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An Archipelago of Coal Pits: Predicting Archeological Features in the Richmond, Virginia Coalfield

Jacqueline Louise Hernigle
College of William & Mary - Arts & Sciences

AN ARCHIPELAGO OF COAL PITS:

PREDICTING ARCHEOLOGICAL FEATURES

IN THE

RICHMOND, VIRGINIA COALFIELD

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Jacqueline L. Hernigle
Author

Approved, May 1991

N Barka
Dr. Norman F. Barka

Virginia Kerns
~~Dr.~~ Virginia Kerns

Stephen R. Potter
Dr. Stephen R. Potter
National Park Service

Antony Fr Opperman
Antony ~~F.~~ Opperman
Virginia Division of Historic Resources

This thesis is dedicated to the memory of my grandfather,
Carl Spencer

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ABSTRACT

Richmond, Virginia contains the sites of the earliest bituminous coal mining in the United States. During three periods of development, the first between 1701-1794, second between 1794-1850, and third between 1850-1939, numerous coal mines were in operation throughout the Richmond basin. These sites are geologically, temporally, and technologically similar to English coal mining sites.

The generation of a predictive model based on English coal mine sites would explain archeological mining features found within the Richmond basin, as well as predict the location and function of features found in future archeological excavations. The predictive model emphasizes four components at the mining sites: 1) types of excavations used to extract coal, 2) mining equipment and buildings, 3) transportation, and 4) attendant manufacturing facilities.

The creation and application of the predictive model for the Richmond coalfield is beneficial on two levels. First, as the Richmond mine sites are slated for capping by the Division of Mine Reclamation, the model can assist in ensuring minimal archeological disturbance to mine sites by predicting mining features associated with the industry. Second, on a broader level the predictive model encourages the generation of hypotheses concerning cultural systemics and how the various subsystems involved in the coal industry change through time. This process leads historical archeologists and anthropologist toward a deeper comprehension of the growth of the Industrial Revolution in the Virginia coalfield, as well as the United States in general.

Jacqueline L. Hernigle
Department of Anthropology
The College William and Mary in Virginia

AN ARCHIPELAGO OF PITS: PREDICTING ARCHEOLOGICAL FEATURES IN THE RICHMOND, VIRGINIA COALFIELD

CHAPTER I

INTRODUCTION

Millions of years ago parts of the Earth experienced a chemical process that would have, in the distant future, far reaching and profound effects on humankind. The process was accomplished by sunlight and chlorophyll transforming the hydrogen, oxygen, and carbon of the air and soil into cellulose and lignin, which eventually were compressed into the complex chemical commonly known as coal. However, coal and its attendant properties only became known to humans during the last several thousand years, and only during the last two thousand years has it been of commercial importance. In the wake of the Industrial Revolution, it became indispensable (Eavenson 1939:2).

Likewise, it has only been since the 1970s and 1980s that mining sites, including coal, gold, silver, lead, and other mineral and ore mines, have become a focus of attention for historical and industrial archeologists (Craib 1978; Hardesty and Firby 1980; Hardesty n.d; Hardesty 1988; Hardesty and Firby 1980; Hardesty and Hattori 1982; Pippin and Reno 1983; Simms 1980; Teague 1980; Teague and Shenk 1977). The majority of all research has been focused on mining in the American West, where "hardrock" (especially gold and silver) mines dot the landscape. The research at these western mining sites has been limited to site surveys and inventories, development of settlement patterns, and the study of imported ethnic labor groups, such as the Chinese, and their mining communities. While these research aspects are indeed integral parts of the whole mining district or area, they are not, and should not, steal the spotlight from the primary industrial activity of mining. The extraction of minerals and ores with an industrial technology is, after all, why the site was created initially (Paul 1963; Young 1970).

A predictive model, or "blueprint," designed to hypothesize possible archeological mining-related features at specific mine sites would be a valuable research tool for historical archeologists and anthropologists. A predictive model for bituminous coal mining would be especially useful, as this type of mining has been virtually ignored by historical and industrial archeologists in North America. Richmond, Virginia contains evidence of the earliest commercial mining of bituminous coal in the United States, and currently these sites face potential destruction from the private and public sector. As the area surrounding present day Richmond continues to grow, commercial and industrial developments are being constructed over these unique, historically significant eighteenth-, nineteenth-, and early twentieth-century coal mines.

With developments encroaching on the Richmond mine sites, the Bureau of Mines and Mineral Resources has been called in to fill these "attractive nuisances." Although the Bureau is being sensitive to potential archeological resources at the mine sites, they do not know what possible archeological mining-related features they could encounter when capping off the mine sites. This predictive model was developed to help predict the potential archeological mining features, based on contemporaneous, analogous English coal mine sites.

Chapter I will provide a theoretical background for this thesis on past settlement pattern and predictive modeling studies that are applicable to the proposed mining research. The mining research agenda designed by Hardesty (1986) will also be reviewed. Chapter II will compare the geologic conditions of the English and Richmond, Virginia coalfields, setting the ground work for further comparisons of the two areas. Chapters III and IV will provide the necessary historical background for the English and Richmond coalfields respectively. Finally, Chapter V will summarize the comparative work in the preceding chapters to provide the predictive model for the Richmond coal mine sites. The test application of the predictive model to a Richmond mine site, as well as suggestions for further research are also included in this chapter. Appendix A contains a detailed description of Richmond, Virginia mine sites, with all the historical and archeological information available, as well as the possible archeological resources at each mine site based on this predictive model. This information, gained from previous archeological investigations at several Richmond basin mine sites, is included as a start to the preliminary testing to which all models and hypotheses must submit themselves for validity.

Settlement Patterns and Predictive Modeling in Archeology

Creating archeological models is a practice born of settlement pattern analyses. Both Julian Steward's (1938,1955) research concerning the effects of the environment on cultures, and Gordon Willey's (1953) pioneering settlement pattern developed for the Viru Valley in Peru, laid a foundation for archeological modeling and provided a backdrop for this study. Steward emphasized that site location correlated directly with specific and identifiable environmental variables. This provided an assumption that could be tested archeologically for validity. Willey's research in Peru did just that. The placement of sites over the landscape, or the settlement pattern, was recognized by Willey as being influenced by the variables of environment, technology, and demography (Willey 1953:1). Using these variables, Willey was eventually able to predict changing settlement patterns diachronically. In the English and Richmond coalfields, site locations also changed over time, based primarily on geologic/environmental constraints (presence or absence of coal), as well as the addition of new transportation routes and technological improvements in coal mining.

Settlement pattern analyses became a focus of archeological studies, especially among prehistorians, during the late 1950s and into the 1970s (Chang 1958; Adams 1965). Prehistoric archeologists began testing the relationships between environmental variables and site locations. During the 1970s, archeologists moved back a step from site location, to study the larger exploitable environment in which the site was situated. The variables within the environment became subject to closer study. These studies are based on the "Mini-Max" assumption, which was taken from Zipf's (1949) principal of Least Effort, as well as Dacey (1966) and Chisolm's (1970) locational analyses. The Mini-Max assumption states that people will structure their lives and living spaces in such a way as to receive the maximum returns for a minimum expenditure of effort (Lafferty et al. 1985:83-91). This assumption would also hold true for mining, which was done with the least investment of money, time, and physical effort. Indeed, this Mini-Max assumption would have to be adhered to by any industrial enterprise in a capitalist economy, if they wished to be successful. The mining sites would therefore, most likely be arranged in concentric circles radiating outward (in order of desending importance to the actual mining) from the mine "core" area.

However, the settlement pattern studies accomplished by prehistorians are not as readily testable, archeologically, as are historic site settlement patterns. Written records allow historical archeologists to verify certain information against archeological data to screen out "noise" from differences in field survey and sampling techniques, erosion, and other site disturbances (Langhorne 1976:73). Using historic sites and settings thereby avoids some of the "self-fulfilling" hypotheses found in studies based on prehistoric data (Paynter 1982:5) More importantly, it allows the refinement of settlement pattern techniques and studies in general.

Finally, settlement pattern, as well as modeling, studies can be divided into two subgroups. Some studies focus on the macro-level settlement patterns, such as region-wide changes in settlement. The Viru Valley project was executed at the macro-level. Other settlement pattern studies have concentrated on the micro-level, with the relationships between activity areas within a single site being the main focus. Antebellum plantation studies have observed such intrasite interaction between planters and slaves, as well as domestic and field slaves (Otto 1984; Singleton 1985; Parker and Hernigle 1990). The information available in the Richmond coal basin could be examined on both a macro, or regional, level and at the micro, or site-specific, level. This thesis will address sites at the micro-level in the Richmond basin with the application of a model, based on analogous sites in England, designed to predict site-specific features that could be encountered archeologically.

Predictive models also draw on the research of economic geographers, who have shifted away from the question of how sites are located where they are, and instead ask why these sites are situated and laid out in a particular manner (Lloyd and Dickens 1972:1). The industrial layout of the Richmond coal mine sites will be understood by studying aspects of the environment that were of economic importance, such as available transportation routes, supply and demand centers, and the availability of new technological improvements.

Through predictive models, archeologists try to reconstruct past features and lifeways (non-observables) from the recognition of patterns (observable data), whether archeological features or material culture, within the archeological record (Carr 1985:20). The observable settlement pattern of the English coalfields is also a potential model which can be "picked up" and transplanted to the similar environment of Richmond, Virginia. Then it would be possible to test the validity of the proposed model, as well as predict and locate similar new sites. Inherent in the term "settlement pattern," is the fact that it will be repeated elsewhere under similar circumstances.

Mining Research Framework

Donald Hardesty (1986) has created a research agenda for developing just such a pattern, or model, for mining sites. Hardesty suggests that the archeological record of mining be examined within the framework of the social phenomena associated with industrialization (Trachtenberg 1982), Victorianism (Baker 1978; Howe 1976), and the expansion of the American frontier (Hardesty n.d.l; Lewis 1984; Steffen 1980). Above all mining is an industrial activity, and therefore one of the most important facets is the use of industrial technologies. These industrial technologies often experienced temporal changes as technology improved (Hardesty 1986:48). To comprehend mining and mining sites the technology behind it must first be understood. Hardesty suggests the use of oral histories, historic documents, and ethnographic observations to construct ethnohistoric models, with archeological evidence providing the missing pieces for the model. The end result of the research is the reconstruction of historic mining technology at the site (Hardesty 1986:48).

However, there are idiosyncracies in the technology systems at mining sites. These are often reflected in unique environments (especially geologic) and historical events (Hardesty 1985:219-221). Each mine site is often effectively a world unto itself because of the different geologic conditions, economic constraints, and available technologies acting together in different ways at each site. This often results in unique and varied site-specific adaptations of the general industrial systems.

Once the industrial aspects of the mining are understood, as well as the land-use patterns, other facets of mining must come into the interpretation of the site's formation. The first and foremost is the high level of mobility at mine sites. The miners moved often, with the mining settlements undergoing frequent cycles of abandonment and reoccupation. The miners' domestic and industrial structures exhibit this archeologically, but most often this pattern of mobility resulted in horizontal stratigraphy. The equipment was also moved, as it was very costly and portable; the brick or stone foundations could be left behind or even disassembled and moved along with the equipment (Hardesty 1986:51).

The cyclic movement, as well as the systematic destruction of portions of the mine sites, often renders the archeological record difficult to interpret. Each new episode of mining also potentially destroys part or all of the earlier mining site (Hardesty 1986:52). New shafts, drifts, slopes, tailings piles, buildings, roads, and canals can all effect the integrity of the archeological record.

Nevertheless, as this research will demonstrate, it is possible to construct a model that will predict the likelihood of archeological resources at coal mining sites, as well as interpret them. The industrial activity areas, as well as the secondary support features of domestic sites, roads, canals, and railroads, exist in various adaptations at each mining site in the Richmond basin. These various adaptations are the result of the influence of geologic, temporal, and economic variables. The Richmond model, constructed from analogous English mining sites, will take these three variables into account at the Richmond mine sites, with the end result being a predictive model that can be applied throughout the basin. Future archeological research at Richmond mine sites would provide a means of testing the validity of the predictive model.

In a broader, more general anthropological sense, the creation of a predictive model for the Richmond coalfield would encourage hypotheses concerning cultural systemics, or in other words the way in which cultures fit their various subsystems together and how such articulated variables shift or change through time (Leone 1978:191). Understanding articulated variables in Richmond, such as the environment and technology, would undoubtedly lead to a better understanding of the economic growth and social changes that occurred in Virginia during the eighteenth, nineteenth, and early twentieth centuries. Economic growth could be assessed by the extent and temporal location of coal mining industries across the Richmond landscape, and social changes could be judged from the industries' ancillary or supportive features, such as workers' housing, community churches, transportation facilities, and other related non-industrial features. In particular, awareness of the systemic relationship between technology and culture, can lead historical archeologists and anthropologists toward a deeper comprehension of the growth of the Industrial Revolution in Virginia, as well as the United States, as an economic as well as social phenomena.

Chapter II

COMPARATIVE GEOLOGY OF THE ENGLISH AND RICHMOND COALFIELDS

One of the most important aspects of creating a predictive model for the Richmond coalfield from the English coalfields is that it is based on a similar geologic structure. Without this type of similarity, the predictive model would have no basis in reality, and therefore no validity. The predictive hypothesis put forward in the preceding chapter is solidly based on two premises. The first is that the geologic conditions of the English coalfields and the Richmond coalfield are similar enough to warrant comparisons between them. Upon this premise is built the second, namely that the historic context of coal mining in England was applied consciously to the Richmond coalfield.

As this is an archeological predictive model, rather than a purely geological one, the overview and comparison will necessarily be relatively simplistic. It is not the purpose of this research to provide a comprehensive geologic account of the formation of coal, or the English coalfields. Nevertheless, an understanding of both the formation of coal as well as the coalfields is necessary for the historic background of each coalfield.

During different parts of the Earth's history extensive, lush forests filled with a multitude of plants covered large areas of the planet. These grew in swampy areas which were periodically covered with more water when there were tectonic movements of the land. The water killed the plants, and when they died they came to rest in a stagnant, watery environment. Sediments flowed on top of the plant debris, covering it in thick layers. As no air entered the plant debris, the slow distillation of methane gas, and smaller amounts of other gases took place in a process called putrefaction. The stagnant water contained other organisms, which after death, sink to the bottom and mix with other plants, pollen grains, and spore remains. The continual deposition of dead material and layers of sediments compresses the underlying debris, first into a jelly-like substance, and later stone-hardness. Thus, peat becomes brown-coal (lignite), brown-coal becomes bituminous, and bituminous becomes anthracite coal by pressure and contact metamorphism (Stutzer 1940:88-104).

Commercially important coal formed only during the Carboniferous (350 million to 270 million years ago) and later geologic formations. The bituminous coal beds in Upper Silesia (region in Central Europe), Westphalia (former German province), Belgium, northern France, America, and England formed during the Upper Carboniferous. The bituminous coal of the Richmond basin formed considerably later, during the Triassic period of approximately 220 million to 180 million years ago (Stutzer 1940:184).

English Coalfields

During both the Upper (350-300 million years ago) and Lower Carboniferous period (300-270 million years ago) the various coalfields in England were established in low lying areas, called basins (the terms coal "field" and "basin" can be used interchangeably). In the Carboniferous period, England cycled through periods of dryness, when substantial forests grew, and then periods of wetness, when water inundated the low-lying basins and buried the plant materials with sediments. These repetitive periods gradually resulted in the formation of Carboniferous rocks, with a further important division known as the "Coal Measures" (Trueman 1954:2).

The Coal Measures refers to geologic strata that contains coal as well as associated clays, shales, mudstones, sandstones, and limestones. The coal seams resting within the Measures reached maximum thicknesses of eight to ten feet, although there are local anomalies. However, in general the English coal strata are fairly thin (Trueman 1954:2).

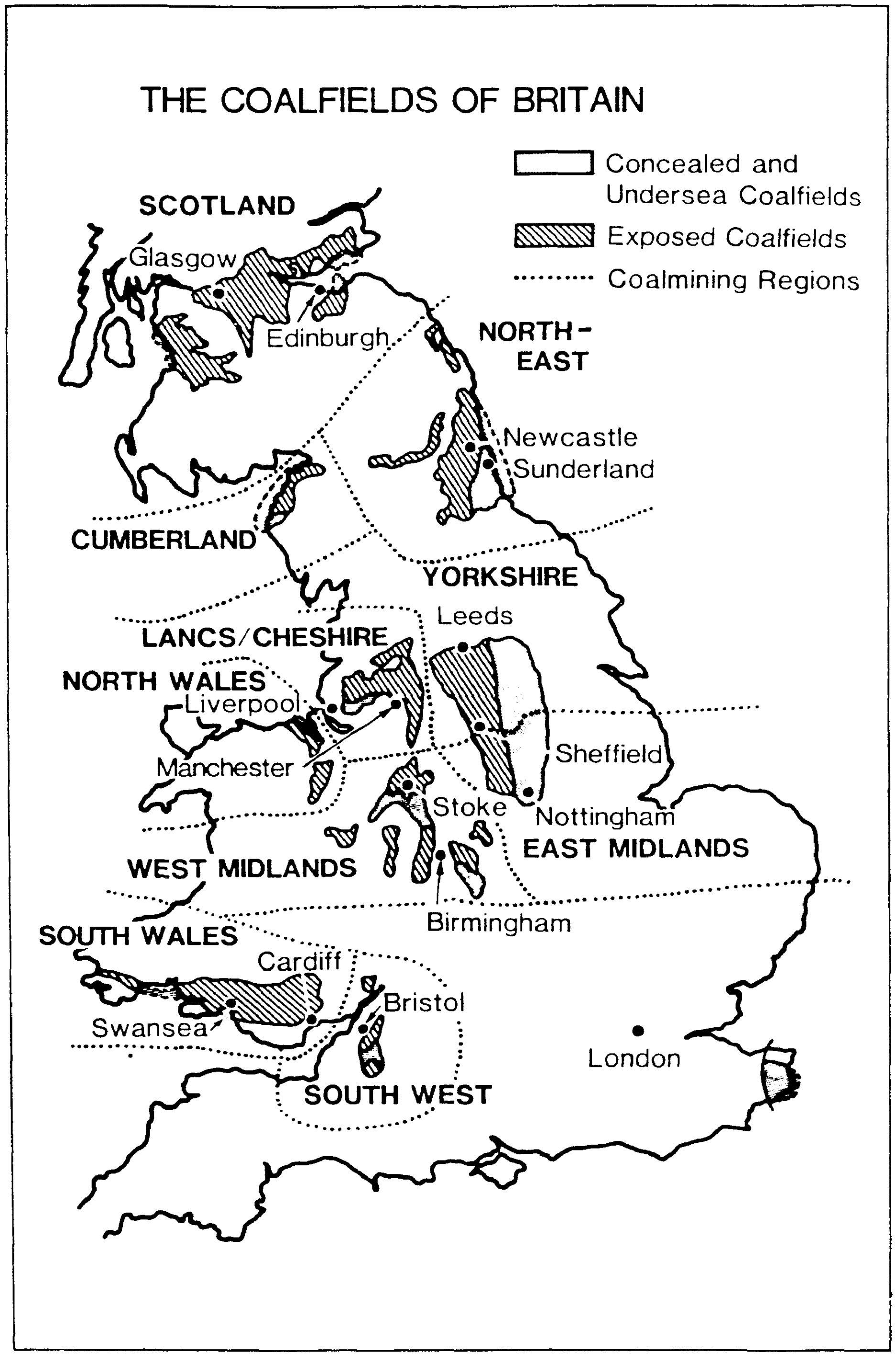
During the Carboniferous period, there were faulting, folding, and tectonic upheavals of the Earth's plates. The folding and faulting broke the Coal Measures causing geologic unconformities in the strata. The unconformities would make efficient mining in the Coal Measures difficult (Trueman 1954:88).

When the coal forming period eventually ended, England was left with several different coalfields within the current political boundaries. These can be broken into ten districts (some of which contain smaller, clearly separated coalfields) of Scotland, Cumberland, Lancashire, North Wales, South Wales, the Southwest, the West Midlands, the East Midlands, Yorkshire, and the Northeast (Flinn 1984:5; Figure 1). The Northeast district, comprised of Northumberland and Durham counties, will be discussed in greater detail because of its similarities to the Richmond, Virginia coalfield. The Northeast coalfield covers 48 miles from north to south, and at its widest point is 24 miles across, with the maximum thickness of the Coal Measures reaching 2,200 feet (Flinn 1984:19; Trueman 1954:292).

By far the most numerous and important coal seams in England are found in the Coal Measures of Northumberland and Durham, in the Northeast area (Figure 2). The coal measures in this coalfield can be divided into three main groups: the Upper Coal Group, Middle Coal (Main Productive) Group, and Lower Coal (Ganister) Group. The Main Coal Group contains all the main coal seams, and the best quality coals, while the other two groups have some coal but are of relative unimportance (Trueman 1954:300).

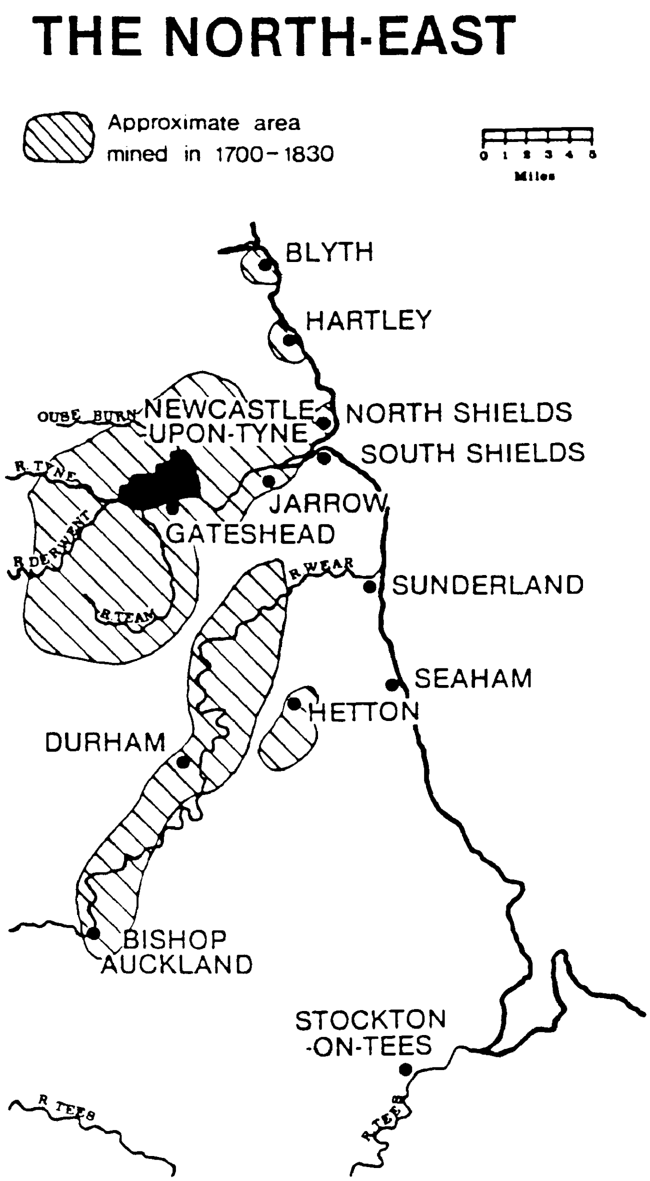
The Upper Coal Group was mined during the eighteenth century, with work principally on the "High Main Seam," which varied between two and eleven feet in thickness. It was easily mined to moderate depths, beginning at outcrops. Other workable seams existed below the High Main, such as the Brockwell, the Main, and the Low Main (Flinn 1984:19). After these upper lying seams had been mined out, exploration downward revealed extensive, high quality coal deposits. By the 1820s, mining of the coals lying much deeper under the Permian magnesium limestone formation began. The greater expense involved in the penetration of the Permian formation led to the establishment of the Geological Survey in the 1830s. However, by 1900 mapping of the coalfields was still incomplete and in some cases outdated.

FIGURE 1



(After Church 1986)

FIGURE 2



(After Flinn 1984)

All these seams are bituminous coal, with bands of dirt and stone limiting the extent of mining. The dirt and other materials limit mining because they reduce the quality, and hence the price, of the coal. There are also high dips, caused by geologic folding and faulting, of between 30 and 60 degrees near the coast that make mining even more difficult. However, elsewhere in the district, the beds flatten out and generally dips of ten degrees are normal (Trueman 1954:292-294).

There are several major faults oriented E.N.E. to W.S.W. throughout the Northeast coalfield. The Hauxley, Stakeford, Ninety Fathom, and St. Hilda faults have all "thrown," or moved the coal seams various distances (varying between 400-1,000 feet). The Stublick fault system serves as a structural boundary between Durham and Northumberland. There are also a second set of faults running northwest to southeast, and while they are minor (between 50-120 feet) they exhibit allow rapid fluctuations in throw (Trueman 1954:308-311). This makes it even more difficult to follow a coal seam during mining.

There are also intrusions of igneous material, known as dikes, into the English Coal Measures. The intrusion of igneous material can partially or completely coke the coal it contacts. However, the individual coal seams are unaffected. It would have been economically fortuitous if the coal seams had been naturally coked as it would have eliminated a time consuming industrial process.

Richmond Coalfield

The Richmond coalfield was formed during the Triassic period (220 million to 180 million years ago) in a basin roughly 33 miles north-south and nine and one-half miles at its widest point. The coalfield, or basin, covers approximately 190 square miles (Woodworth and Shaler 1899:393) through the counties of Chesterfield, Henrico, Powhatan, Goochland, and Amelia (Figure 3). The geologic basin gradually filled with plant debris, which eventually became bituminous coal. Historically, the geologic formation of the Richmond basin has drawn numerous geologists to speculate about the creation of the basin and the deposits within the basin (see Volney 1803, Lyell 1847, Daddow and Bannan 1866, Clifford 1888, Russell 1892).

Geologically, there were probably only three episodes of coal formation within the basin (Wilkes 1988:3). The Coal Measures present within the basin contain an unknown number of coal beds, although probably not as many as the English coalfields. However, the coal seams are considerably thicker than in Britain, reaching 40 feet in some locations, within the Richmond basin. These coal seams are interspersed with layers of sandstone, shale, slate, siltstone, clay, and fireclay, and rest on a gneiss or granite basement (Woodworth 1901:480).

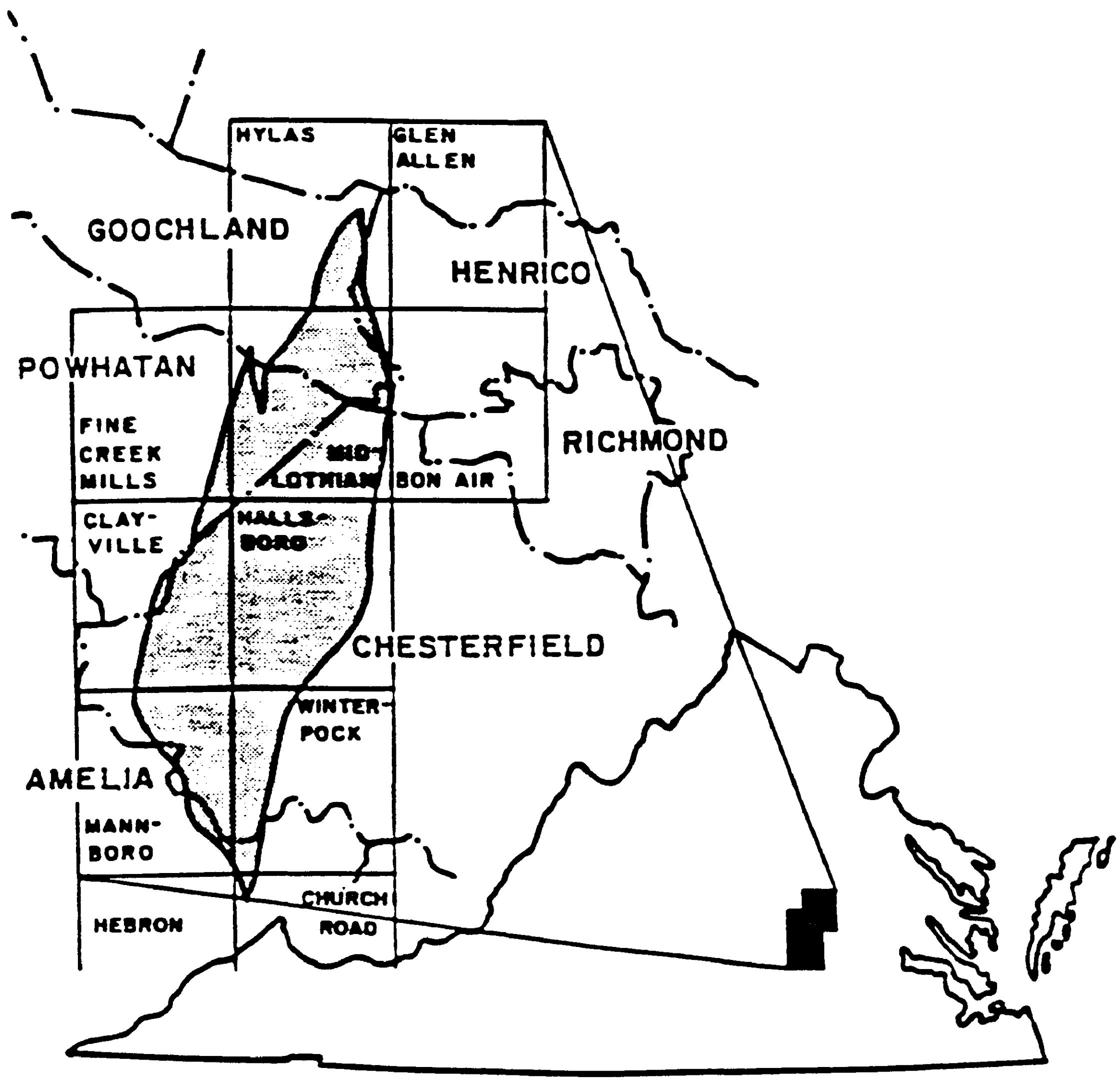
The unstable tectonic area on which the basin is situated, from time to time, caused land to lower or raise, resulting in unconformities from faulting and folding in the coal seams. The coal beds are steeply dipping (20 degrees to vertical) and it is not uncommon to have abrupt changes in depth while working in the same coal seam. The upheavals resulted in the coals resting at the bottom of a fold being blocky, bright, and attaining a maximum thickness. The "blocky, bright" state of coal is the most desirable form coal can achieve. However, the coals at the crest of a fold are rendered distorted and crushed. When this occurs, it becomes unsalable and is often considered waste coal (Wilkes 1988:3).

In addition to the faulting present throughout the basin, igneous intrusions in the form of dikes and sills of diabase intersect and follow the coal beds. When the igneous rock contacted the coal, the result was natural coke. The natural coke beds are present only within the main basin, as the small separate basins were apparently depressed beneath the general level of intrusion (Woodworth 1901:481). The natural coke provided the Richmond mines with a highly prized industrial fuel that did not naturally occur in England.

As the Richmond coal basin is trough-shaped, the edges along the east and west margins outcrop. The earliest and easiest mining occurred at these locations. The eastern margin has been the most productive, especially within the small detached basins (Union, Black Heath, Stonehenge, and Cunliffe) where the coal deposits are fairly thick and uniform (Woodworth 1901:482;Wilkes 1988:18). The western margin has been less worked, as the strata are more visibly disturbed. Gneiss blocks, underlying the basin, have faulted substantially, displacing the coal beds (Woodworth 1901:482).

The central northern part of the basin contains coal seams which are relatively flat at the surface, but there is evidence that suggests the existence of heavy faulting at deeper levels. The center of the basin most likely contains the thickest coal beds, but these have

FIGURE 3



Map of Virginia showing insert of Richmond coal basin. The coal basin is shown in relation to the counties as well as Virginia quadrangle maps (After Wilkes 1988:1).

also been faulted along with the granite and gneiss basement. The strata above these dislocations absorbed the movements in folds and faults long before they reached the surface. The absence of geologic "expression" of these upheavals on the surface created very difficult mining conditions because there were no indications of faults or folds visible to perspective miners.

The southernmost end of the coal basin contains the deepest coal seams. These seams, like the central northern part, are also faulted. Mining operations in this area would have had to over come the problems of both faulting and great depth (Woodworth 1901:480).

Within the Richmond basin, five mining districts are recognizable: Carbon Hill, Deep Run, Midlothian, Clover Hill, and Manakin/Huguenot Springs districts (Figure 4). The Carbon Hill district is situated on the northwest margin of the basin, and has a north-south trend between Big Swamp and the James River. This district also contains the Edge Hill basin, a remnant of erosion from the main basin. There are fewer faults and minor rolls, or folds, of the coal measures in this area, and it appears to have the best geologic conditions in the basin for mining (Wilkes 1988:11).

In the Carbon Hill district, there are four major coal seams. Uppermost is the "Coke Seam" (average of 6-8 feet thick), followed by the "C Coal" (average of 2-5 feet thick), the "B Coal" (average of 3-5 feet thick), and finally the "A Coal" (average of 6 feet thick). These seams dip an average of 25 degrees to the west (Wilkes 1988:11).

The Midlothian district lies on the east-central margin of the main basin at the James River and continues south to the end of the coal measures in Chesterfield County.

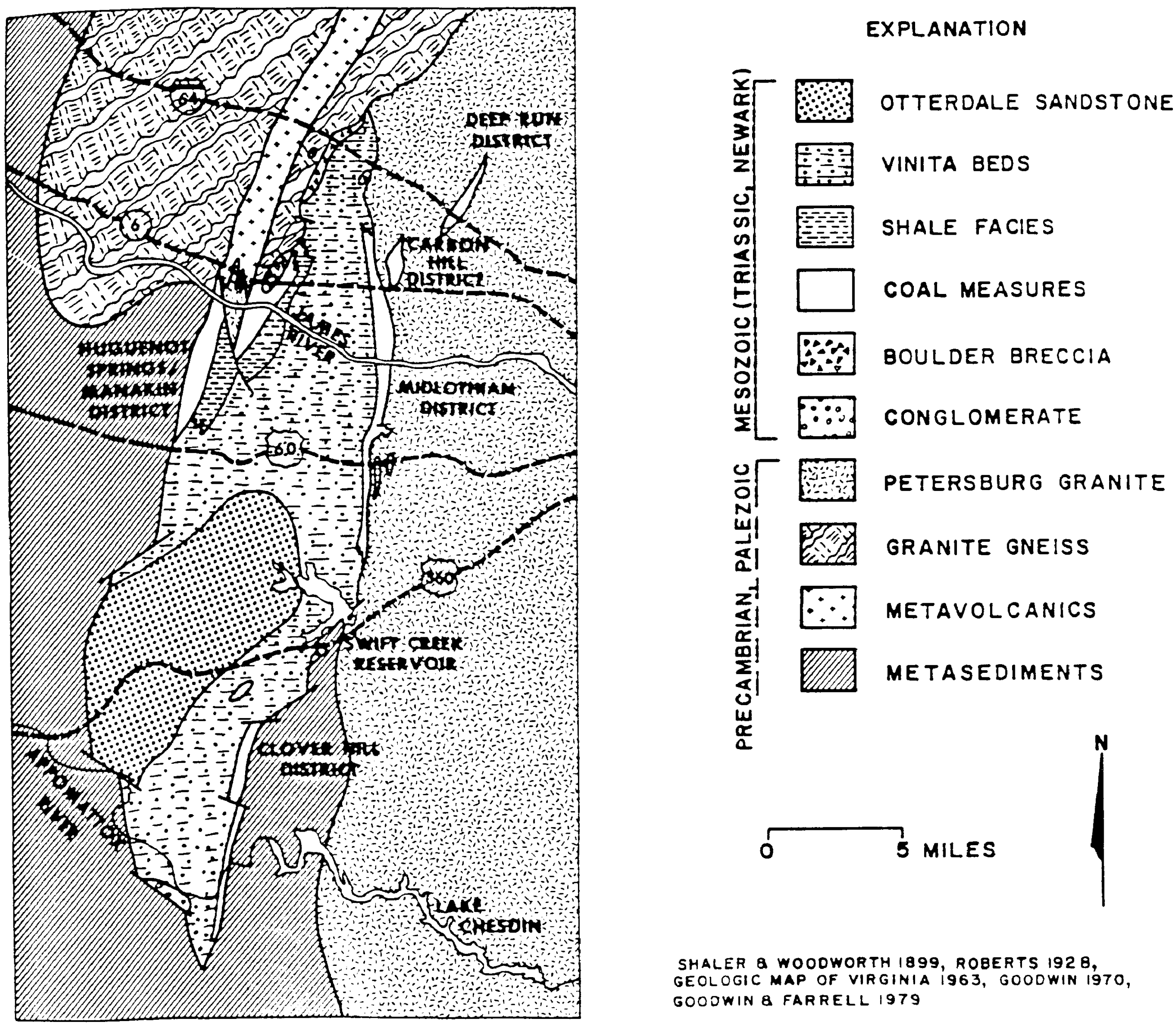
This district contains four smaller basins; two, the Stonehenge and the Union, are separated by faulting and subsequent erosion from the main basin. The smaller Black Heath and Cunliffe basins are still attached to the main basin, with a fault serving as a boundary (Wilkes 1988:18).

There are also four major coal seams in the Midlothian district. The uppermost coal seam is an average of five feet thick, the second coal is one foot thick, the third is an average of 12 feet thick, and the fourth is 14 feet thick. These seams dip an average of 22 degrees to the west (Wilkes 1988:18-19).

The Clover Hill district is located on the southeast margin of the basin. There are three coal seams in the district. The uppermost coal seam is three to five feet thick, the main coal seam is seven to twenty feet thick, and the bottom coal seam is four to six feet thick. There is a severe pinch in the coal measures in the Clover Hill district called the "Garrett Trouble," approximately 1,300 feet west of the basin margin outcrop. For a time, the Garrett Trouble effectively ended mining efforts when it was encountered. However, after it's path was located, the shafts were positioned to the west of the Trouble and mining continued (Wilkes 1988:29).

The Manakin/Huguenot Springs district is situated on the western margin of the Richmond basin. At least two coal seams, an upper coal (7 to 12 feet thick), and a lower coal (8 to 15 feet thick) were mined, with several other coal seams noted (Wilkes 1988:32; DeBow 1860). The dip of the seams varies markedly from 20 degrees to 70 degrees in both the west and east directions. The district is located squarely on fault blocks, and when mining at the edge of the fault block, the coal was found to thin out

FIGURE 4



Geologic map of the Richmond coal basin. This map has been compiled from several sources (After Wilkes 1988:4).

and roll, and resume its thickness at the next block. However, parallel north-trending normal faults displaced the coal measures as much as 10 feet. The dip also changed abruptly from northeast to southeast, ranging between 15 and 90 degrees (Wilkes 1988:32).

Summary

While the English coalfields (particularly the Northeast coalfield) and the Richmond coalfield, were formed during two different geologic periods, are nonetheless strikingly similar. The geologic structures of each coalfield contain bituminous coal measures that have been subjected to a good deal of tectonic plate movement after their deposition. This resulted in faults, rolls, folds, and other geologic unconformities within the coal-bearing strata. The general geologic structure of both coalfields was deformed by these movements of the lower strata, and the deformities affected the coal mining efforts in the same ways. These geologic unconformities caused serious planning problems when coal mining began, as the faults and folds often threw the coal seams a great distance from their original positions. Often both English and American time and money were invested to relocate a thrown seam before mining could continue.

There is only one difference between the English and Richmond coalfields, namely the presence of naturally coke seams. The Richmond coalfield contains several natural beds of coke, while the English coalfields lack these economically important seams. However, the presence of natural coke seams in the Richmond basin does not preclude comparison of the two coalfields. It merely removed an expensive step in the industrial process that readied coke for sale in Richmond, Petersburg, and other American markets.

The forementioned geologic similarities between the English and Richmond coalfields, serves as a primary foundation for further comparisons. In fact, this similarity is prerequisite for additional work, for without confirming the basic geologic variable, subsequent research would be discredited.

CHAPTER III

HISTORY OF THE ENGLISH COALFIELDS

Introduction

This chapter will provide the necessary historical background for the social, economic, and technological development of the English coalfields and a context in which the mining techniques of each period take place. The history of English coal development is divided into three periods: Roman occupation of England through the seventeenth century, the eighteenth century, and the nineteenth through early twentieth century. These historic divisions are based on technological and social advances that had impact on the coal industry. The mining techniques adhered to during each period, both above and below ground, are also discussed as they are the basis for a Richmond predictive model. When possible, previous industrial archeology research undertaken on English coal mine sites will be referenced, as it will provide additional data for subsequent interpretations of the Richmond, Virginia coalfield.

English Coal Mining History:

Roman occupation through the Seventeenth Century

The Romans living in England before 400 A.D. evidently made use of the surface coal outcroppings to some extent, for remains of coal fires were located during archeological excavations of several Roman villas and towns in the Northumberland region of England (Eavenson 1939:5; Hudson 1976:79). However, there is no mention of coal in the English Domesday Book (1085), an economic compendium which lists things of monetary value within the country. Nef (1932:6-7) believes that while it is reasonable to assume that coal may have been burned for some time prior to any documents recording such use, it is equally reasonable to assume, from the absence of these records, that coal must have been little used in the twelfth century, in comparison to the thirteenth century, when there are numerous references that establish the fact that coal was being worked in "almost every field of England and Scotland." Nevertheless, this absence of records may point instead to the everyday use of coal by common folk. Such an ordinary item as coal may have been beneath official notice.

The dearth of references to coal mining prior to the thirteenth century is perhaps due to the severe punishment that could be incurred for "breaking ground" in English forests or uncultivated areas. Digging coal, as well as other subsurface minerals, would have damaged prime hunting grounds frequented and protected by the English aristocracy. The Magna Carta, signed in 1215, gave greater freedoms to the general population, and the Forest Carta, in 1217, granted freemen the right to "erect a mill in his own wood, or upon his own land, which he hath in the Forest, to make a marl-pit, or ditch...," thus bestowing the right to break ground (Eavenson 1939:9). In later years, Common Law widened this right from the forest and uncultivated lands, to encompass all land (Galloway 1898:18).

Nevertheless resourceful individuals could still obtain coal in England without breaking the law. One of the earliest, and easiest, methods of obtaining such coal was used at the coalfields of Fife and Northumberland, which extend to the North Sea. The constant wave action eroded the coal from the banks and deposited it along the shore line. This "sea cole" was collected by women and children, and sold as fuel to replace the rapidly dwindling supply of wood in England (Eavenson 1939:9). By 1226, sea coal was common enough in London to have a street, "Sea Cole Lane," named after it (Galloway 1882:29).

The first document recording the actual mining of coal in England is dated 1243. The document indicates that the miners, or "colliers," had already moved beyond merely quarrying the surface coals, and had begun to dig trenches into the dip of the seams where they outcropped (Salzman n.d.:4). Numerous mine areas, or "collieries," began to extract coal in the mid-thirteenth century. In fact, Queen Eleanor left Nottingham Castle in 1257 because the coal mined nearby caused terrible, noxious smoke when burned (Eavenson 1939:10).

When the sea coal reached London it was undoubtedly purchased by artisans and the poor. Smiths, limeburners, ironmongers, and brewers all required a constant source of heat for their trades (Nef 1932:11). Poor families purchased low quality coals to burn for domestic purposes, as they could not afford wood. However, Edward I in 1306, "...by proclamation prohibyted the burneing of sea-coale in London and the suburbs..." in an effort to avoid the "sulferous smoke and savour of the firing" hovering over London (Hair 1969:2). In 1307, a proclamation forbad limeburners in London to burn coal because "...an intolerable smell diffuses through the neighboring places and the air is greatly infected to the annoyance of magistrates, citizens, and others there dwelling and to the injury of their bodily health" (Calendar of Close Rolls 1307:537).

The distaste for coal fires is due, in part, to the nature of the coal itself. The sea coal and coal taken from outcrops tended to be of poorer quality, which produced a "continual cloud of choking, foul-smelling smoke, leaving a heavy deposit of thick black soot on clothing and faces" (Nef 1932:12-13). The medieval habit of building fires in the center of a room, with no chimneys as yet to direct the smoke out, also contributed to this problem (Nef 1932:13).

Prejudice concerning coal was rooted deeply in English culture of the thirteenth century. Coal had developed such a poor reputation that "...the nice dams of London would not come into any house or roome where sea coales were burned, nor willingly eat of the meat that was either sod or roasted with sea-coal fire" (Hair 1969:2). This prejudice was most likely confined to the wealthy because King Edward was subsequently forced to stricter measures concerning his prohibition on coal use. These rigorous acts included punishment for a first offense by "pecuniary mulcts," (monetary fines) and on a second offense their furnace was to be demolished. However, twenty years later coal was used to heat the royal palace (Hair 1969:2). Absolute necessity forced the English population to adopt a fuel regarded by a large number as not only disagreeable, but actually noxious (Nef 1932:158).

Necessity, often the mother of invention, came in the form of the increasing scarcity of firewood, reaching crisis proportions in the fifteenth and sixteenth centuries. Queen Elizabeth and King James, during their respective reigns, sent commissions out into the countryside to investigate the deforestation problem (Nef 1932:158). An anonymous petitioner to Queen Elizabeth reported that "...all the country villages round about the land within twentie myles of the Sea are for the most part dryven to burne of theis coales...most part of the woods are consumed" (H.M.C. Report on the Mss of the Marquis of Salisbury:330-331).

The depletion of timber was, in part, due to the natural limits of forest found within the island of England. Scholars also seem to agree that the population of England, between 1550 and 1700, increased more rapidly than any continental country (Nef 1932:163). This population growth occurred in the city of London, as well as in country villages. The increase in population also required an increase in the number of inexpensive timber-built dwellings, which again contributed to the escalating timber shortage. These settlements became the domestic market for the correspondingly expanding coal industry. Burgeoning industries and manufacturing placed an additional demand on the limited timber supply. An intricate balance of these factors insured that the success of English manufacturing interests was dependent upon the adoption of coal as fuel (Nef 1932:163-164). Without coal, an industrial expansion once begun could scarcely have persevered.

In 1590, a proclamation declared that "within our Realme of England the use of coales is of late years greatlie augmented, not onlye for fuelle, but also to serve divers tradesmen and Artificers" (Lansdowne Mss 65 no. 9). Prior to the sixteenth century, only the limeburners and smiths made any constant substantial use of coal (Nef 1932:201-206). Saltmakers, alum manufacturers, and other refining industrial processes also required a source of constant heat, such as coal could provide in place of wood (Nef 1932:206-215). By the mid-seventeenth century, when the process of coking coal was discovered, nearly all manufacturing industries requiring heat could make use of some grade of coal (Nef 1932:216).

The Crown, in an attempt to capitalize on this growing market, raised taxes on the chaldrons of coal shipped down the Tyne River in keels from Newcastle mines. A chaldron was a basket-shaped container, which held approximately 2,000 pounds of coal drawn from the mines. Chaldrons were loaded into keels, or boats, for transport to London or other markets (Eavenson 1939:11).

In the sixteenth century, Newcastle coalfields produced a great deal of coal for the London market, as well as foreign ones. In 1602, the Newcastle Company, composed of 28 members, shipped 9,080 tons of coal in 85 keels. In 1615, 400 keels were utilized for shipment; in 1616, 13,675 tons of coal were shipped, and in 1622, 14,420 tons left Newcastle mines (Hair 1969:2).

In the last half of the sixteenth century, the Grand Lease near Newcastle was purchased by the Society of Free Hosts. The Grand Lease was a 99-year lease of the manors and royalties of Gateshead and Wickham, which included coal deposits, held by

Queen Elizabeth (Hair 1969:4). The Society of Free Hosts was a group of coal owners founded in 1404, originally to entertain and cultivate merchants in Newcastle for the purpose of buying the local coals (Eavenson 1939:12).

Queen Elizabeth herself bore no great love for coal, and attempted to restrict its use to artisans and the poor (Eavenson 1939:12). The Queen placed a tax of 1 shilling a ton on coal exported from Newcastle. This tax later became known as the "Richmond shilling" when Charles II granted it to his son, the Duke of Richmond. This particular coal tax lasted until repealed in 1831 (Eavenson 1939:13).

Early in the 1620s, the Society of Free Hosts of Newcastle was able to monopolize the Tyne River coal trade. In an attempt to rectify this problem and reap the profits, Charles I tried to seat himself as sole vendor for all coal loaded into English or foreign ships. However, the outbreak of the Civil War halted this machination (Eavenson 1939:13).

During Charles II's reign, Parliament again tried to loosen the hold Newcastle coal owners had on the market by fixing the price of coal. Newcastle mine owners decided to let market demand set the price, so the mines were shut down in 1665, thus increasing the demand. The law was quickly repealed by Parliament in the face of rapidly rising coal prices (Eavenson 1939:13-14).

The Newcastle area is part of an even larger coal-producing region known as the Durham and Northumberland districts. This region contains approximately seven mining districts within its boundaries. Four of these seven had no access to water and were classified as "land-sale" coal mines. Land-sale of coal consisted of coal deposited in piles at the marketplace primarily for domestic consumers to purchase. The other three districts, known as "sea-sale" mines, were situated on waterways and could easily ship coal to English and foreign markets. The sea-sale coal was purchased at dockside from waiting keels by tradesmen, usually in substantially larger amounts than that sold at the land-sale markets (Nef 1932:24).

The land-sale mining districts of Durham and Northumberland grew during the sixteenth and seventeenth centuries in an area of scattered small villages, rather than towns. The district included south Durham, the upper Wear Valley, northern Northumberland, and the upper Tyne Valley (Nef 1932:36-42). No large collieries developed during the seventeenth century (except in south Durham) in the region because of the high cost of transporting coal overland to market. However, the number of small collieries was high. The domestic and small industry markets absorbed the majority of the coal extracted. By the end of the seventeenth century, the total estimated output of these districts in Durham and Northumberland amounted to approximately 100,000 to 150,000 tons (Nef 1932:42).

During the sixteenth and seventeenth centuries, the sea-sale districts were comprised of the Tyne Valley, the lower Wear Valley, and the Northumberland Coast. The collieries within these areas took advantage of the nearby navigable water, even to the extent of excavating pits on the banks of the Tyne River. These pits were dug with two variables in mind, the distance to water and to the coal below the ground surface (Nef 1932:25-26). The less energy expended obtaining the coal and then getting transport to market, the more profitable the mining venture became.

Several different types of coal were extracted from the Durham and Northumberland region. Often a particular colliery was known for producing coal that was suited for special needs; however, numerous grades of coal could come from one pit. These included the broad categories of anthracite, or "culm," and bituminous coal (Nef 1932:109;111). There were even more specific grades within these categories, which produced different results when burned. These coals were distinguished by the size of a block, or chunk of coal, the brightness of the flame produced when burned, any odor of the resulting fumes, and presence of damaging by-products (such as soot and slag) (Nef 1932:111-112)

By the seventeenth century, there were enough trades in which specific types of English coal were needed that the coal grades present within each mine became important to colliery owners and merchants. Coal extracted from each pit was sorted, or "riddled," to separate each grade of coal. Colliery owners in the Durham and Northumberland districts differentiated between at least three grades of coal. The larger coal chunks were of a "better" grade than the smaller ones. Better grade coal was sought by homeowners for kitchen and fireplace burning, beer brewers, soapmakers, and glassmakers. The better grade coal produced a bright clear flame, without as much sulphurous smoke and odor. The lower grade, smaller, coal was used by brickmakers, dyers, smiths, and lime burners (Nef 1932:112).

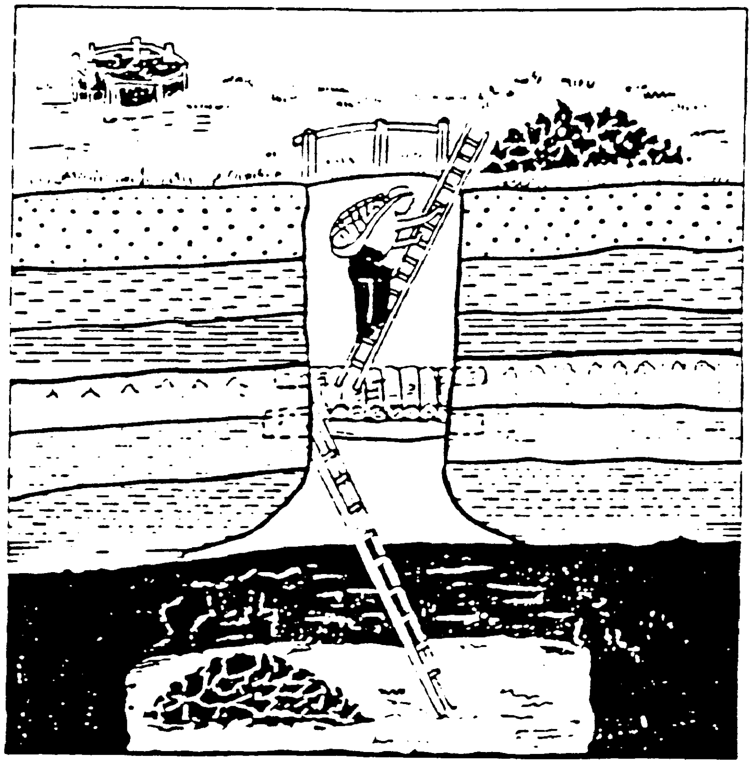
Mining Techniques: Roman Occupation to Seventeenth Century

The mining methods and techniques used to extract coal during the twelfth century through the seventeenth century did not change drastically. This was primarily due to the relatively complex geologic nature of the coalfields, as well as the state of English technology during these years.

During the twelfth through the fifteen centuries little mention is made about the actual extraction of coal. Sea coal was simply collected from the shore; however, the earliest true "mining" was done along the outcrops of coal seams (Raistrick 1972:51). Trenches were dug with shovels, either following the seam or cross-cutting it, until the seam dipped too sharply into the ground. Shallow pits were also excavated into the coal seams, with ladders used to provide access. These pits, called "bell-pits" because of their shape, were circular openings with a shaft excavated, or "sunk," to the coal seam (Figure 5).

After removing as much coal as could be safely taken out with pick and shovel, given the potential danger of the sides collapsing, the pit was abandoned. A new one was then started nearby and the debris from the new pit shoveled into the old working (Raistrick 1972:52). A cluster of bell-pits, dating to the sixteenth century, were located in Denby, Derbyshire in the 1960s. The pits varied from 5 feet 10 inches, to 16 feet in diameter, five feet to 12 feet apart and approximately 20 feet in depth (Griffen 1969:392-394). These pits were short-lived, and left little surface evidence of their existence. In Northumberland and Cumberland, remains of bell-pits and early drift workings are still

Figure 5



Bell-pit (After Butt and Donnachie 1979).

visible as shallow depressions on the landscape or distinct changes in soil color (Hudson 1976:81).

In Bristol, in 1684, there were over 70 bell-pits, which listed only 123 colliery workers. Apparently, virtually every pit was worked by only one or two men (Ashton and Sykes 1967:67). These bell-pits did not require surface buildings at the pithead. The temporary nature of these pits precluded the need for this unnecessary expense. The miners' tools and corves (baskets) necessary to extract the coal would be carried from home each day. The Jack rollers (a small diameter windlass situated between two upright poles, and positioned across the diameter of the shaft) would have been dismantled and carried to the next new pit site.

Bell-pits, crowded close together along the coal seam, were labor intensive when compared to the amount of coal obtained. Therefore, during the late fifteenth and sixteenth centuries workings were extended outward along the seam from the bell-pit base. These "gangways" could also be made in a "drift mine" dug into a coal seam from its outcrop on a hillside (Raistrick 1972:52).

When gangways were used in deeper workings there was the potential for roof collapse because of the supporting coal being removed. A method of leaving unworked blocks, or pillars, of coal amidst a rectangular pattern of extracted coal was known as "pillar and stall" or "bord and pillar" (Raistrick 1972:52). The large pillars of coal supported the weight of the overlying strata. Timber and stone were used to provide additional support. This method, however, was able to "win," or obtain, only a small percentage of the coal available in a mine (Raistrick 1972:52). The seventeenth-century mining operations continued using these methods below ground.

On the surface, "horse whims, horse gins," or "whim gins" were used to hoist coal, men, and water from the deeper mines, replacing the Jack rollers. Whims were operated by horses or mules traveling around a circular track, rotating a central vertical axle by means of a radial connecting shaft. A large winding drum was fixed on the vertical shaft, around which the rope was wound for hoisting. The mechanism was powered by the moving animal (Raistrick 1972:112).

The sixteenth and seventeenth centuries were times of vital change in the scale of industries, with the introduction of new technologies, and the appearance of large capital concerns and monopolies. It was a period of transition during which industries, organized in the medieval pattern, came to an end and their place was taken by larger organizations. These larger concerns led into the new industrial practices of the eighteenth century, and especially the nineteenth century, known as the Industrial Revolution (Raistrick 1972:200).

Eighteenth Century

Experimentation characterized the seventeenth century. People were testing new techniques and innovations and the fruit of these advances was apparent in the eighteenth-century English coal mining industry. The availability of coal and the relative scarcity of timber caused experimentation with the mineral in various trades. The increasing acceptance of coal throughout the eighteenth century, especially in the smelting industries, increased the market demand. These factors naturally led to an expansion of the coal industry during the eighteenth century. This period served as the basis for the subsequent Industrial Revolution.

England possessed an ideal setting during the eighteenth century for the growth of a prosperous coal industry. There were affluent estate owners who opened mines to expand their wealth or pay the debts incurred by preceding generations. The wealthy landowners were one of the few groups in England capable of financing such large expensive endeavors; unlike landowning aristocrats elsewhere, members of the English wealthy class were not afraid to immerse themselves directly in their industrial ventures. During the eighteenth century in England, dukes, baronets, and marquises competed with each other, and unhesitatingly combined forces with merchants, bankers, and industrialists to meet rising capital demands in the coal industry (Flinn 1984:4).

The impoverished class of landless squatters was also an important factor, as they comprised the actual work force necessary to make a coal mine successful. The most important component, however, was the independent businessman. The businessmen combined the skills of both merchants and gentlemen, enabling them to generate capital necessary to open mines, as well as operate them as successful businesses (Trinder 1982:10-11). The combination of English aristocrats, poor squatters, and entrepreneurs worked unknowingly to create the eighteenth-century industrial landscape in which coal played an increasingly major role. However, it is doubtful whether the term "industry" would have been a concept understood by the people of that time. Coal mining, while growing steadily, was simply seen as the way in which some people made a living, just as farmers did. During the early eighteenth century the potential for coal mining as a true industry was revealed, rather than realized.

At the beginning of the eighteenth century, the majority of the coal mined in England was intended for domestic purposes. The relatively small amount destined for industrial consumption at this point did not equal the demand of the domestic market. There were still technical problems that prohibited using coal in some industrial processes, especially in the large and lucrative business of manufacturing iron goods (Flinn 1984:1).

Technical problems also plagued coal mining itself. By the early eighteenth century the most accessible coal seams had been worked out and mining had reached a critical point. If coal mining was to continue as a lucrative enterprise, the workings had to be extended to greater depths; however, the greater the depth, the greater the technical difficulties became. Drainage and ventilation problems prohibited progressing deeper into the earth until technology could surmount these obstacles. Coal mine owners simply extended their mining operations along a horizontal plane across the landscape, rather than a vertical one, until these problems were solved (Flinn 1984:1).

One of the more serious technical problems encountered during eighteenth-century mining was removing accumulated water from the workings. Thomas Savery invented an atmospheric, or fire, engine which was utilized as a coal mine pump in 1705. Savery advertised this invention as "The Miners' Friend" (Ashton and Sykes 1967:36). Water could be lifted from a depth of approximately 16 feet and forced an additional 42 feet beyond that into the air (Ashton and Sykes 1967:37). However, the atmospheric engine, using both steam and atmospheric pressure, caused condensation within the mine workings and was considered dangerous. Thomas Newcomen altered the ineffective condenser and marketed an improved version of the pump which used atmospheric pressure alone to raise water. Several of these Newcomen engines were installed and working at collieries by 1715 (Eavenson 1939:26-27). The Newcomen engines were considerably cheaper per gallon of water raised that the horse whims previously used. They also allowed greater quantities of water to be raised from greater depths (Flinn 1984:116).

In 1769, James Watt had further refined the pump engine by creating a solely steam-powered engine, known as the Boulton and Watt steam engine (Ashton and Sykes 1967:39). However, a far greater number of the atmospheric engines were used at coal mines until the last quarter of the eighteenth century. This was in part due to the expensive terms of rental for the Boulton and Watt engines. Boulton and Watt also advertised a savings in coal used as fuel, which did not appeal to the mine owners because they always had on hand the soft, broken, unsalable coal needed to fuel the Newcomen atmospheric engines (Ashton and Sykes 1967:40). The Newcomen patent expired in 1733 and the first Boulton and Watt engine was used for coal mine drainage in 1776 (Flinn 1984:121).

Even the most effective pumping engine available during the eighteenth century was virtually useless against the devastating power of underground water. Water-borne disasters that trapped and killed miners were common enough that in 1749, some Englishmen advocated establishing a Record Office. The Record Office would inspect old workings to avoid such catastrophes. However, no action was taken until 1840, when a Mining Record Office was formed in London. This inactivity was the result of the highly individualistic nature of British coal mine owners (Ashton and Sykes 1967:41).

The second battle fought within the mines was waged against a less visible enemy -- poisonous gases. As pumps enabled mining to proceed to greater depths, ventilation, like drainage, became more difficult. In the smaller mines worked in previous centuries, only carbonic acid gas, known as "chokedamp," affected miners. However, in the larger, deeper pits methane or marsh gas, called "firedamp," surpassed the chokedamp in deadliness. Chokedamp suffocated miners, but gave warning by first extinguishing their lights; firedamp gave no warning and often simply exploded upon contact with flame or spark (Ashton and Sykes 1967:41-42). Miners had to attempt to rid the workings of accumulated gases and they used various methods to do so. Ventilation, if correctly managed, could clear the shallower workings of gases. However, firedamp collected at the roof of the workings and was difficult to adequately dilute by ventilation. Changes in the color of candles flames were used to detect the presence of firedamp in the workings. Specialized "firemen" were used to explode the gases by wrapping themselves in water-soaked rags, and crawling along the gangway floors holding a long pole with a lighted candle at the end. The flame was then used to ignite the gases, and the fireman would fling himself to the ground and hopefully be spared the explosion overhead (Ashton and Sykes 1967:44).

Truly effective ventilation systems were not developed until the early nineteenth century. During the eighteenth century, the typical system of ventilation was to sink a vertical air shaft some distance from the main shaft to create air circulation. The air shaft utilized the principles of physics because during the summer the higher outside air temperature and lower air density caused air to enter the mines through the air shaft and exit from the main shaft, and the pattern was reversed during the colder months. Brick and stone chimneys were constructed over the air shafts and served to increase the effectiveness of the ventilation (Ashton and Sykes 1967:47).

This ventilation system was sometimes assisted by coal fires and the accompanying draft created by them. Some mines suspended fire-baskets in the air shaft, others kept furnaces burning at the bottom of a shaft. This was often unpleasant for the miners, as John Watson wrote in 1749 that "...A Large Lamp stands at the Bottom of the shaft which they keep in continual blaze for the Convenience of Air etc. which makes the Shaft as bad to Ride as a Kitchen Chimney" (Watson Journal 1794).

Initially, the air rising and descending these shafts was not regulated in any way. This resulted in some distant parts of the mines not receiving any air circulation, especially as the mines were expanded. These spots became havens for the deadly firedamp and chokedamp gases. In response to these problems, vertical "stoppings," or partitions, of brick or wood were built at gates and headways within the mines. These stoppings enabled air to be directed into a particular part of the mine. There were also lateral stoppings and doors to further regulate air flow. "Trappers," young boys and sometimes girls, were responsible for the operation of these doors (Ashton and Sykes 1967:48-49).

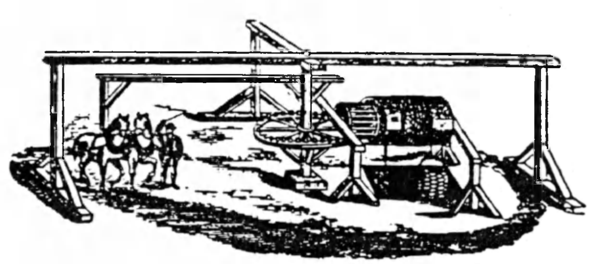
However, the small advances in ventilation in the eighteenth century only served to partially negate the problems of gas explosions. The true dilemma lay rooted in the means of illuminating the mines. Typically miners carried open flame candles which readily ignited any gases present. In the early eighteenth century, Carlisle Spedding invented a steel mill to light extremely gaseous mines. The steel mills used flint and steel, with a wheel crank spinning steel teeth against the flint producing a steady stream of sparks. A steel mill was rarely used because of the additional expense involved, as a separate boy was required to crank the mill. Also a number of explosions in the 1780s were directly attributed to the steel mill's sparks (Ashton and Sykes 1967:51).

The number of explosions increased along with the depths reached in mines. The leaking water in mine shafts had created a small movement of air, but this stopped when pumps were installed. Simple ventilation systems were developed within the mines, but were little help. The dilution of firedamp with a little air often made it more volatile (Ashton and Sykes 1967:42-43). The combination of ineffective ventilation, deeper gaseous workings, and open flame candles for illumination served to render coal mine explosions so frequent an occurrence that Northern coalfield mine owners asked the ***Newcastle Journal*** in the 1760s not to mention them anymore.

Nevertheless, the improving ventilation and drainage techniques all served to make extraction of the deeper coal strata within a mine more readily possible. Obtaining coal was the primary objective at each mine, and to this end a mechanical winding apparatus at the pithead was constructed. This apparatus was used to raise colliers and coal corves. The simplest device was the windlass, which was cranked by hand. This served smaller mines that did not require hoisting from a great depth. At the larger pits a "cog-and-rung gin" was used (Figure 6). This consisted of a drum mounted over the opening of the shaft; cogs on the drum meshed with others on a horizontal wheel, and the axle of this was fixed to a stern-pole to which a horse was harnessed. The direction in which the horse walked determined if the rope coiled around the drum or descended into the mine (Ashton and Sykes 1967:54).

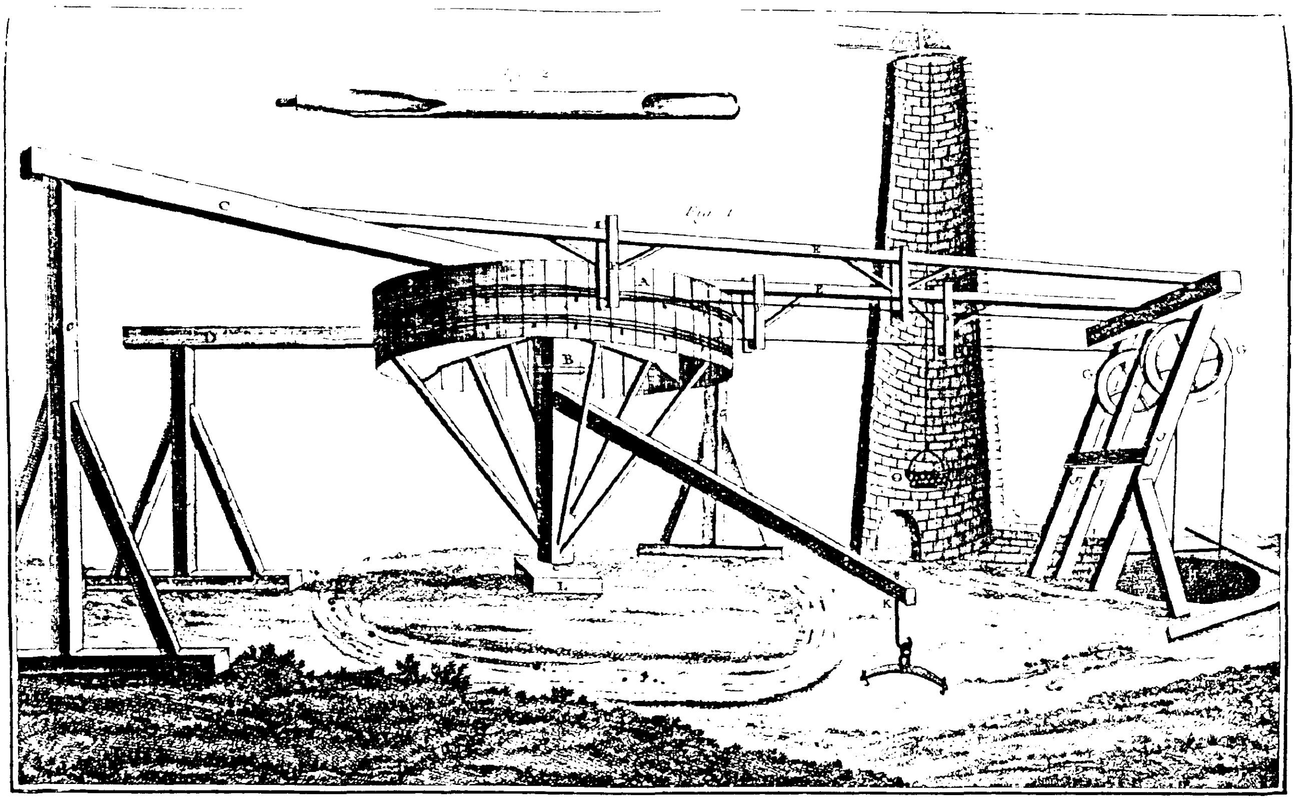
The "whim gin" was an advance over the other two hoisting methods. A pulley was set above the pithead and a winding rope passed to a vertically mounted drum a distance away (Figure 7). The whim gin was constructed away from the pithead allowing easier access to the mine and less danger of the gin being debilitated by an explosion. The whim gin operated with a larger drum which resulted in faster winding. This gin, like the cog-and-rung gin, was powered by horses. At smaller mines, one horse was sufficient; however, at deeper operations more hoisting power was necessary. Typically four horses, working in shifts with other horses, were harnessed to the whim gin and were tended by boys (Ashton and Sykes 1967:55; Figure 8). These horses were housed in stables near the mine.

Figure 6



Cog and rung gin (After Galloway 1898).

Figure 7



One horse whim gin. A. Drum fixed to axle B; C. Chief beam in which the pivot of the axle turns; D. Transversal beam; E. Cross-pieces holding up the framework of the pit pulleys; F. Rollers on which roll the ropes of the drum; G. The great pulleys on which the same ropes roll as they descend into the pit H; J. Cross-pieces holding up the pulleys; K. The swing-bar to which are attached as many as eight horses; L Piece containing the hole in which the axle rotates; M. Air shaft, 38 ft. high, built of brick and communication with the pits by the covered galley N, in order to extract the damp; O. Heater suspended on a rope by means of which it can be pulled up of lowered to refill with lighted coals; P. Device to prevent the wind from blowing into the air shaft (After Morand 1764-1777:696).

The winding machines hoisted not only coal but also men into and out of the mines. Miners could ride in a coal corve, or on a wooden "horse;" however, the most common method was looping the rope end and placing one leg in the loop, holding the rope with an arm. They used their free leg and arm to steady themselves while riding the rope. Boys would often cling to the rope or sit balanced on the men's knees. Not surprisingly, accidents resulted from this mode of transport. Stones fell down the shaft, or corves of coal were sent up the shaft while colliers were descending, resulting in a "wedding." The most frequent types of accidents were from failure to securely grasp the rope or the upsetting of the basket when the horses on the surface moved erratically (Ashton and Sykes 1967:56).

As mines grew deeper, the horse gins could not provide the hoisting power necessary. In the mid-eighteenth century, Michael Menzies patented a device called the "menzie." This used a descending tub of water as a weight to hoist coal and men to the surface. The menzie used the same apparatus that the horse gins did, eliminating the expense of new equipment. The rope wound around the drum with one end in the winding shaft, and the other in a neighboring worked-out pit holding the water tub. When the tub reached the pit bottom, a valve opened releasing the water. The descent of empty corves in the winding shaft pulled the empty tub up the water pit. The water was pumped to the surface and reused as a weight (Ashton and Sykes 1967:57).

The early steam engine, developed as a water pump, was slowly adapted to the winding process. In 1763, Joseph Oxley obtained a patent for "drawing coals by fire." A colliery in Northumberland used this method; however, it was not exceedingly

Figure 8

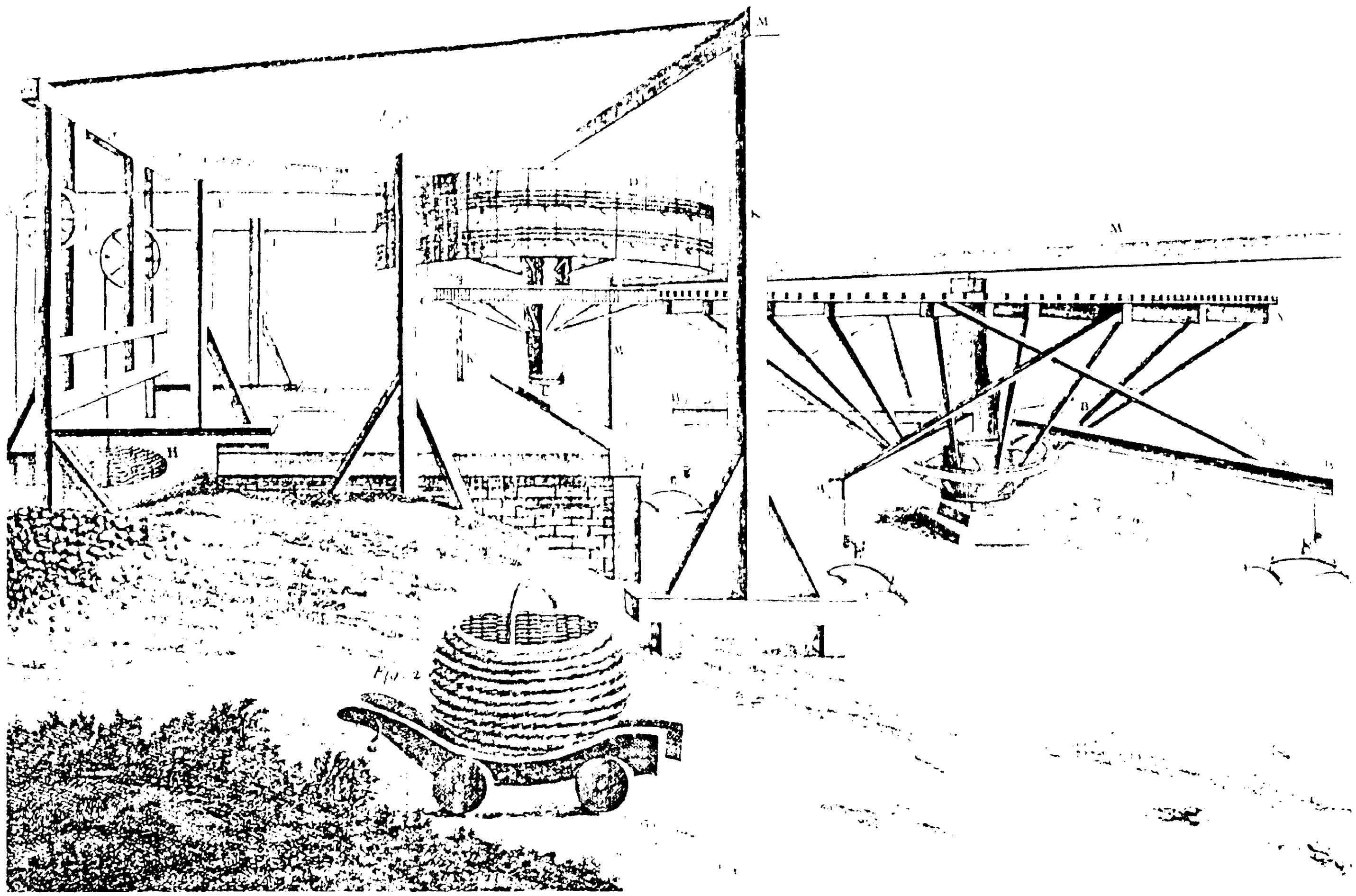


Diagram of a four-horse winding or "whim" gin at a North-east pit. In the forground a corf rests on a wooden "rolley" (After Morand 1764-1777:697).

successful because its action was very irregular. After some alterations, it was converted into a pumping engine which supplied water to an overshot wheel which in turn raised the coal. This engine was popular in Northumberland, Durham, and Scotland during the 1770s and 1780s. The combination of the steam engine raising water and the water-wheel raising coal was in use until the early nineteenth century in some northern mines (Ashton and Sykes 1967:57-58).

Further modification of steam engines resulted in attaining the necessary rotary movement for winding operations. The winding engines, or "whimseys," were of a smaller horse-power and size than those designed to pump water. These could be mounted on four wheel carts and transported from pit to pit. Boulton and Watt introduced their own winding engine in the 1780s, modeled after their pumping engine. Numerous others marketed their versions of the winding engine (Ashton and Sykes 1967:59-60).

By the first quarter of the nineteenth century, steam engines had displaced horses and water-wheels at most of the larger collieries. The steam engines allowed faster winding at greater depths, enabling the mines to be worked even deeper (Ashton and Sykes 1967:60). The adoption of steam engines in both pumping and winding was an expensive investment. The engines required housing to protect them from the elements, and typically the engine houses were made of stone or brick. These structures, coupled with the large initial investment in the engines, served to make the collieries more dependent on deeper mining. Moving often from mine to mine would have been more expensive than simply extending the underground workings.

On the surface, transportation problems also inhibited the early eighteenth-century coal industry. The costs of overland transportation were high and freight charges were disproportionate to the cost of mining. This raised the price of coal beyond the reach of most customers. Water navigation helped defray these costs, but only for the small percentage of mines situated nearby. The majority of the thick coal seams were located well away from water, and so could not be worked during this period (Flinn 1984:2). Later in the mid-eighteenth century, iron rails laid on top of the wooden wagonways improved the overland transportation and lowered it's cost (Raistrick 1972:53).

However, some major technical advancements in trades were necessary for the coal industry's growth and some of these were developed in the first two decades of the eighteenth century. Abraham Darby had refined the use of coked coal as a substitute for the charcoal utilized in iron smelting. After the process of smelting iron with coke was discovered, the leading industrial families made technological and financial contributions to the field of coal mining. This opened a large consumer market for the coal industry to fill (Flinn 1984:2). Later in 1784, discovery of the process of iron puddling and rolling resulted in consolidated iron and coal concerns rising in the coalfields of Scotland, Wales, and Britain. This generation of capital would profoundly affect the British coal industry of the nineteenth century (Ashton and Sykes 1967:6).

Mining Techniques: Eighteenth Century

The coal industry developed throughout the eighteenth century into a business that required many knowledgeable decisions to determine the success of each mining operation. The planning necessary for a colliery called for a high degree of expertise concerning mining geology and mining technology. There were also administrative skills in demand, in both supervisory and accounting areas.

On the ground surface, colliery management had to see that pumping, winding, and ventilation machinery were functioning and manned by sufficient labor. The colliery counting house had to keep accurate record of miner's attendance, amounts of coal produced, and wages due each collier. The sale of coal at pitside (from individual consumer contracts) had to be recorded, cash received counted, and bills sent out. The coal sent overland or by navigable water to market was also recorded. Lastly, a detailed log of costs and receipts had to be kept for the information of the owner or lessee of the colliery (Flinn 1984:52).

Several costs were incurred before a coal mine was even established. By the beginning of the eighteenth century, the most easily mined outcrops of coal had been worked-out, or at least worked to a depth where drainage and ventilation problems had precluded continuing (Flinn 1984:69). The science of geology was in its infancy in the eighteenth century and was of little help predicting the coal strata across England. Therefore, boring was the most reliable method for ascertaining the existence of coal underground, as well as the continuity of a seam, locating faults, and for determining the most advantageous location for the drainage shaft (Flinn 1984:70-7).

A boring team consisted of one master-borer and four laborers, who were contracted by various collieries (Flinn 1984:72). Boring was accomplished by placing a wooden tripod over the boring site, from which the boring rods were suspended by rope, pulley, and block. The boring rods were in sections and screwed together, with a chisel bit at the bottom and a brace-head with four arms at the top. The brace-head was used to rotate the rod into the ground, with pressure from the spring action of a freshly-felled tree helping (Flinn 1984:71).

The boring rod loosened material as it descended. This could be examined either by lowering a scoop down the bore hole or by raising the cuttings by attaching a hollow tube known as a "wimble" or "sludger" to the end of the rod (Flinn 1984:71). This slow process required constant removal of the rod and sectional additions as depth increased. A boring in 1750, of 123 feet in Durham, took 40 days (Robertson 1970:13). Often three bores were necessary to determine the inclination of the seam, as the drainage pit had to be located at the lowest point of the seam (Flinn 1984:72).

After enough stratigraphic knowledge was gained from boring, the next step was determining the method necessary to gain access for working the coal. Bell-pits were still sunk in the more remote areas where demand for coal was still low. The larger-scale workings required deep shafts to reach coal seams. As the sinking of a shaft was labor-intensive and expensive, the shafts were no larger in diameter than necessary. The shafts ranged from five feet to fifteen feet in diameter; less frequently, square shafts of six feet were excavated (Flinn 1984:74).

As the shaft was excavated, various types of shoring were used to hold back the ground water as well as the shaft's sides. In the Northeast coalfield, stone or brick linings were inserted to a depth corresponding with the first rock stratum encountered. Wooden "cribbing" was sometimes used in the shaft temporarily and was replaced with brick or stone lining later. If there was a great deal of ground water, a wooden lining called "tubbing" was necessary. The wooden tubbing could withstand water pressure up to 100 pounds per square inch. By the end of the eighteenth century, cast iron was often used for tubbing (Flinn 1984:76).

After the shaft had been sunk and adequately shored for safety, the pithead gear for winding and hoisting was erected. The pithead gear, which brought coal corves, men, and water to the surface, was typically dismantled from an old mine shaft and reassembled at a new one. The wooden frame construction of the winding "whim gins" made such reuse easy. Other structures were also built at the pithead. Air shafts, built of brick, helped rid the mine workings of gas (see Figure 7). The more substantial collieries constructed pithead platforms directly adjacent to the mine shaft for solid footing when colliers were working at the pithead (see Figure 8).

With the surface pithead winding gear hoisting soil and excess water, the coal seam to be worked was eventually reached. At this point one of two methods for removing the coal had to be chosen. The first method, called "pillar and stall," "bord and pillar," or "short and narrow," involved taking coal from the passages and leaving square or rectangular pillars of coal. The deeper the mine, the larger the pillars because the pillars supported the weight of the overlying strata. This method was universally accepted in the

Northeast coalfield, as well as other areas (Flinn 1984:82-83). The geologic conditions in the north would not allow any other method (Flinn 1984:87).

The second method was the "longwall," "Lancashire," or "Shropshire" system. This technique removed the broad length of a seam, replacing it with timber props to support the roof. Waste coal, unsaleable, was piled into "goafs" or "gobs," and the props could be removed. The longwall method extracted 100 percent of the coal seam, as opposed to the much smaller percentage won in pillar and stall. However, this system tended to produce greater amounts of surface settling, which could be costly if colliery buildings or equipment were damaged in the subsidence (Flinn 1984:83).

The chosen underground system was overseen in most larger collieries by "viewers." Viewers combined the skills of managers, engineers, surveyors, accountants, and agents to determine the most efficient and effective method of working a colliery. A viewer could be a permanent fixture at one large colliery, but typically the colliery owner or operator (renting the mineral rights from the landowner) hired them through contracts. Therefore, the day-to-day operations below ground fell to a colliery foreman or "overman." The overman determined schedules of colliers and their attendant work force, as well as where the coal was worked within the mine (Flinn 1984:53).

By the mid-eighteenth century, mining jobs had become more highly specialized than in the preceding centuries, and thus more efficient. Each task was fulfilled by a specific individual, rather than an individual performing several jobs as in previous centuries. There were various jobs necessary below ground including blacksmiths, bricklayers, masons, carpenters, engineers, as well as the individuals directly involved in the actual mining. "Colliers" or "miners" were general terms which included all people immediately involved in the job of extracting coal. The experienced collier was known as a "pitman" (Flinn 1984:349).

Each prospective pitman or collier typically went through a period of apprenticeship, as required by many other trades of the period. These boys were hired at a young age, between six to ten years, as the belief was that skilled pitmen were made through an early acculturation in the mine environment (Flinn 1984:349). Boys, or sometimes girls, were first hired as trap doorkeepers, or "trappers." They were responsible for remaining awake for 12 to 14 hours a day to open and shut doors as directed when coal corves passed through or ventilation was required in sections of the mine. They remained in this position for four to five years. When they were promoted, they were accountable for the movement of corves from the working face to the pit bottom, with or without the help of horses or ponies. After two to three years at this laborious task, they were again advanced to the position of a "half-marrow" or "putter," responsible for shoveling coal into a corf. The next step was one year spent as a "put-and-hewer" where half the day was spent on the tram or wagonway overseeing the transport of the corves to the pit bottom, and the other half was spent learning to work the coal. A "hewer," the actual miner of coal, taught the put-and-hewer techniques necessary to obtain coal. The position of hewer was very desirable, as hewers made the most money and worked fewer hours. Conversely, they also were more prone to being injured or killed in a coal fall or explosion at the working face (Eavenson 1939:22-23). Nevertheless, the amount of money and prestige apparently offset the dangers and discomforts of the mines, for an old Lancashire song says "Collier lads gets gowd and silver, Factory lads gets nowt but brass" (Eavenson 1939:39).

The amount of money due was carefully monitored, as colliers were not considered above trickery. The "banksmen" received coal at the pithead and tallied the corves to ensure that they were properly filled "...for otherwise both the Hewers and Barrow-Men will confederate under ground, and they will be sometimes so Roguish as to set those big coals so hollow at the Corfe bottom, and cover then with some small coals at the top of the Corves" (C.J. 1708:32).

The above average wages given the men and boys who worked in a mine were necessary. They faced dangers and, from one day to the next, did not know if they would be able to support their families. The hazards they encountered laboring were underground were slow to be understood in the eighteenth century. Likewise, the technical advances that helped alleviate some of these problems were also slow in coming.

After colliers were considered experienced, and therefore valuable, colliery owners went to some lengths to retain their services. As the coal industry grew, miners were more in demand, and could in turn demand higher wages and better benefits. Miners were concerned about their families, and one of the surest ways of luring a miner to work at a colliery was to provide housing.

Colliery housing during the late eighteenth century was a common expense for collieries. The houses were typically constructed in rows, with an eye toward cutting construction expenditures. At Tyneside colliery, the floor plan of a two-story brick or stone house measured 15 feet by 18 feet and was divided into two rooms on each floor (Forester 1948:8). In some areas, houses were exceptionally small, measuring 8 feet by 9 feet. These were constructed of local stone with brick floors and pantile roofs (Beastall 1975:28). The Butterley Company in Derbyshire built houses in terraces of 20 to 50 houses. These were two-story houses, with a two-room floor plan. Each house had a large garden, privy, and coalshed (Griffen 1969:507). A study of the various houses provided by iron companies for their ironworkers and colliers between 1790 and 1830 determined that the two-story houses with a four-room floor plan were the most typical of industrial housing (Iron Industry Housing Papers).

A solitary eighteenth-century document contains information about the contents of these colliery houses. In 1764, James Spence, in discharge of a debt, surrendered the following goods and chattels to his employer, Sir John Hussey Delavel of Hartley colliery:

> two Close Beds and Bedding, on open Bed and Bedding, one Dresser and Cupboard, seven pewter Dishes, six Delf Dishes, twelve Delf plates, one Oak Cupboard, one Chest, two Chairs, one Table, one small Ditto, Two large Boiling pots, one small Ditto, one Water Shell, one Milk Can, one Spinning Wheel, one Frying pan, one Gridle, one pair of Teamses, one Box Iron and Heater, six Wood Trenchers, three White Delf Bason, one Looking Glass, one pair of Barrs, one Wood Bowl, one Chimney Crook, and three wood Stove (Delaval Ms).

As the mining settlements were constructed as close to the mines as possible, geologic conditions usually placed the communities in relative geographic isolation. Colliers were recognized as a social entity by the end of the eighteenth century.

The miners and their families were thought to be clannish, because outsiders as dirty, primitive, and beneath a cultured person's notice. This idea was firmly entrenched in the English psyche long before the ***Methodist Magazine*** (1815:581) referred to miners as "...Wild as the untaught Arab's brood, The Christian savages remain...." Miners with children were believed to "encourage rather than check...their growing fondness for liquor..."; miner's wives were "strangers to cleanliness, frugality, or economy." The miners themselves "in all transactions with their employers readily sacrifice the principles of truth and honesty to promote their own selfish designs" (North of England Institute of Mining Ms:48). Simply put, the miners' houses were covered with coal dust, as was everyone in the community, libations were one favored form of entertainment, and their wages did not allow for much in the way of extras around the home.

By the end of the eighteenth century, the stereotype remained but mining communities were changing. Housing conditions had improved, schooling was becoming more available, churches were being built, and social clubs and trade unions were emerging. These changes correspond directly with the increase in employee wages and the employers' profits as the coal industry expanded. New uses for coal and the innovations which allowed the expansion of coal mining worked hand-in-hand to raise the English economy from dependence on human-, horse-, wind-, and water-power to dependence on coal (Flinn 1984:455).

This expansion affected the men and boys laboring within the mines. The length of gangways grew and attention was focused on the quickest mode of locomotion to the pit bottom. Initially, horses and ponies were used within the mines to pull the sledges in larger northern collieries. However, if the geologic conditions precluded a ceiling high enough to accommodate the animals, the putters pulled the coal on sledges to the pit bottom. In cases of thinner seams, boys crawled pulling a sledge of coal behind them with a harness, known as the "guss" (Ashton and Sykes 1967:62-63).

In some collieries, wheeled corves were used instead of sledges. These were pulled by horses on parallel planks of wood placed the length of the gangway. Iron pins were driven into the wood to keep the corves on the track. Counterparts to these "waggonways" existed on the surface as well (Ashton and Sykes 1967:63).

The substitution of metal for wooden planks occurred between 1768 and 1771. The wood rails were replaced with plates of cast iron with an inner flange to keep the wheels on the track. Henry Cort later exchanged malleable iron for the brittle cast iron plates, which resulted in an expansion of railways in the 1780s and 1790s (Ashton and Sykes 1967:64).

In 1805, John Curr, a notable mining viewer and engineer, adapted the steam engine to underground haulage along the iron railways. The combination of iron plates, or later iron rails, and steam haulage considerably diminished the loads the young putters and hewers had had to deal with previously.

However, the ultimate result of the iron railway was not what John Curr had intended. The wheeled corves could be pulled or pushed by young children as well as, or better than horses. In fact, the expense of employing children was much less than the care and feeding of horses and ponies. As time went on, the children employed to move the corves became younger than those who had dragged the sledges before the railways were developed (Ashton and Sykes 1967:68-69).

Nineteenth and Early Twentieth Centuries

If seventeenth-century coal mining was characterized by experimentation and the eighteenth-century by expansion, then the nineteenth-century coal industry can be described as a period encompassing both ideals, particularly expansionism. W. Stanley Jevons (1865:vii-viii) claimed that coal was of central significance in English economic supremacy when he wrote "Coal alone can command in sufficient abundance either the iron or the steam; and coal, therefore, commands this age -- the Age of Coal."

By 1830, the growing English coal industry was already one of the country's leading industries; industrial consumers had overtaken the domestic market by this time (Church 1986:5). Numerous advances in the areas of winding, ventilation, and drainage came about as a result of the adoption of steam engines at collieries. There was also progress with safer forms of lighting within the mines. These advances served to contribute both towards satisfying consumer demand and expanding coal mining as an industry.

The centuries of accumulated mining knowledge, especially gained during the eighteenth century, made deeper, safer, and more productive extraction of coal possible. Mining design and methods of extraction had improved, There were also a group of extremely discerning men, known as viewers, who were experienced engineers and able to pool their information for the industry's benefit. The problem related to coal mining uppermost in all minds was how to sustain the ever-increasing output levels required by nineteenth-century industries (Church 1986:5).

The iron industry had established itself by the nineteenth century as having the greatest demand for coal. Other industries, such as non-ferrous metal smelting, pottery, flour-milling, and brewing, followed suit transferring to coal-based sources of energy (Church 1986:5). To supply not only these demands, but also the continuing domestic consumers, the coal industry again had to expand. As the more easily mined seams had long since been worked out, expansion had to depend on more intensive working of existing mines and sinking new shafts in the spots previously avoided as too dangerous, and, thereby, too expensive (Church 1986:5-6).

The earlier workings had been situated only near rivers, coasts, or canals for easy transport to market. With the advent of improved railway transportation collieries could open in areas away from water that were previously unmined (Church 1986:6). Between 1830 and 1913, access to markets was facilitated by three major developments: the expansion of the railway system throughout England, steam-powered iron ships to export coal, and the improvement in dock and harbor conditions (Church 1986:37).

Of all the coalfields being mined during the nineteenth century, the Northeast coalfield continued to dominate the coal market, in part because of the availability of three navigable rivers, the Tyne, Wear, and Tees. Until the 1850s, those colliery owners had a virtual monopoly over the other coalfields, as the others lacked waterways and had to pay high land-carriage fees, resulting in more expensive coal (Church 1986:38). In 1850, Braithwaite Poole remarked with admiration concerning the intermeshing railway, wagonway, and dock networks of the Northeast coalfield (Church 1986:39).

Indeed railways were the key to opening up the "land-locked" coalfields. The railway links to London, the primary marketplace, had improved with the opening in 1852 of the Great Northern Railway, the London and North Western, the Great Western, and the Midland Railway Companies (Church 1986:42). Numerous railways were constructed in response to the increasing demand for coal and the inability of the canal and overland systems to support the increasing coal traffic. The appearance of railways doomed all but the most favorably situated canals (Church 1986:44).

As the industry continued to expand, the costs of such expansion continued to rise as well. There were fixed capital expenses such as sinking and opening pit, surface and subsurface fixtures, transport facilities (horses, stables, wagons, engines, railways), and office facilities. There were potentially also expenses for housing, farm buildings, farms, brickworks, and sometimes coke works. The coke works required brick ovens and chimneys to remove gases and provide draught to the coal being fired (Church 1986:108-109).

Prior to 1830, the capital for these facilities and expenditures initially came from individuals. However, the increasing expenses necessary to mine profitably led some wealthy landowning proprietors to enter into financial partnerships (Church 1986:122). Some independent wealthy nobles continued to be important as coal producers and financial provenders; nevertheless, the joint stock legislation of the 1850s diminished the relative industrial contributions of landed colliery owners (Church 1986:123). The individual owners did not entirely disappear for the local landsale markets were still in their hands. Coal mined from drifts, levels, or shallow pits did not require the capital that partnerships could provide (Church 1986:124).

The colliery owners who did need partners looked to men with experience, good business connections, and wealth. Railway men were a logical choice, as were professional mining engineers. These individuals became partners by purchasing shares, thus providing a source of capital necessary to run the colliery. Iron masters were also in a position to provide large sums of capital. Indeed, before 1830, most large iron masters operated their own collieries to supply their iron works. These men were, in effect, the financial successors of the wealthy landowners (Church 1986:126;127).

As could be expected, problems of policy and profits inevitably caused friction in partnerships. The passage of the Limited Liability Act of 1855 and the Joint Stock Companies Act of 1856 enabled suits to be filed, shares to be transferred, and limited liability to become an option. The combined effects of the 1860s depression in England and on coal-producing iron companies resulted in the slow conversion of partnerships into limited companies (Church 1986:133). By the mid-nineteenth century, the business administration of collieries had become as elaborate as the subsurface workings.

The size of a colliery work force necessarily expanded, just as the collieries themselves did. The total number of colliery workers in 1830 was estimated at 109,000, and by 1913 it had risen to 1,095,000. The size of the coal mining general work force increased ten-fold during the same period (Church 1986:188).

The work force was almost entirely male, with women working in, or at, coal mines comprising 3.5 percent of the labor pool in 1841. It became illegal for women to work underground in 1842, resulting in a decrease in the percentage of women in the workforce to 2.5 percent by 1851, and to less than one half that figure after 1861 (Church

1986:191). While the exclusion of women from subsurface work was based on the stated moral premise that they should be home tending "womanly" duties, it also allowed more men to occupy the lucrative positions below ground. As the total number of women employed was relatively small, the greater public outcry was saved for the laboring children.

Children, especially young boys, had traditionally followed their fathers, brothers, and other male relatives into the mines as soon as possible. Not only was this an additional source of income for the family, it also in effect promoted the boy to a man's status. At first the new miners worked in an atmosphere of adventure. However, the public viewed the use of children as "...strange and as new as the wildest dreams of fiction " (Ashley 1903).

Juvenile labor was restricted by age with the Act of 1842, but the age limits really did little for boys who began work at between 10 and 12 years of age. The boys received no education and were confined for 10 hours a day in a cramped, unhealthy environment and were thus mentally and physically exploited (Church 1986:197). It was only after numerous laws were passed prior to 1887 that the minimum age of 12 was introduced throughout the coal industry. However, the trend away from employment of young boys took place primarily because the advances in technology, particularly in ventilation and underground haulage, made it more cost effective to purchase machines rather than pay children (Church 1986:199). Technological advances reduced the total expense of young boys employed in these types of underground jobs.

Mining Techniques: Nineteenth and Early Twentieth Centuries

Until the 1880s, Britain experienced an almost continual growth of collieries, both in the amount of coal produced and the number of pits opened. As the mining became increasingly difficult, due to greater depths and dangerous strata, mining techniques had to be improved. During the nineteenth century, two major areas of technical improvement were in "access" technology and "operational" methods. The access technology permitted miners to reach and work the coal in safer conditions. Operational methods involved planning mine working layouts, obtaining the coal, and transporting it to the surface. A final technical improvement was in the preparation of coal for sale (Church 1986:311).

The planning and work involved in establishing a new coal mine, such as locating the coal by boring, and sinking the new shaft was primarily the responsibility of experienced viewers. As the nineteenth-century collieries were owned by wealthy men, the expense of a consulting viewer was not prohibitive; the consequences of not retaining a viewer's services could be much more costly if sinking began and no coal was found. The viewers provided expertise built upon previous generations of coal mining experience (Church 1986:312).

As costs rose throughout the nineteenth century, boring assumed a much more important role in mining. In the 1840s, steam power had helped reduce the amount of physical labor and time it took to bore. Hydraulic lubrication techniques and core recovery, accompanied by the diamond core drilling method, made it possible by the 1860s to increase the rate of boring. The diamond drilling method cut a solid core that could be retrieved for sectional analysis. Diamond drilling made mining much more predictable because the precise location and depth of water and coal strata could be known prior to sinking a shaft. This method was less expensive and became widely used by the 1880s (Church 1986:313).

The advances in boring also helped during the process of sinking. Most sinking operations of the nineteenth century utilized skills commonly employed in the Northeast coalfield where deep mines were the rule rather than the exception. By the 1850s, these methods were in use across England, although the specific geologic conditions at each site still dictated the precise techniques to be employed (Church 1986:315).

Before 1862, sinking operations typically opened only one large divided shaft. By 1840, the use of two separate shafts was becoming popular, with one upcast shaft for winding and a nearby downcast shaft for pumping. Shafts were primarily circular in Britain and Wales, and rectangular in Scotland. The diameter of the shafts was determined by the amount of coal raised and ventilation requirements. The smaller mines had shafts of 4.5 feet in addition to large, divided shafts with diameters of 18 feet. By the beginning of the twentieth century, the large collieries typically paired shafts of 7.5 to 9 feet, or single shafts of 10.5 to 13.5 feet (Church 1986:315).

Once a shaft location had been chosen by a viewer, the topsoil was removed and brick or wood lining placed inside the shaft to prevent slides. Sinking progressed by picks, shovels, hand rock-drills, and often gun powder during the early nineteenth century; steam, compressed air, and electric drills were introduced later in the century (Church 1986:315).

While there were serious dangers to the sinkers, such as rock falls and poisonous gases, the greatest threat came from the presence of water. The prevention and removal of water entering the workings proved to be the most difficult aspect of sinking a new shaft. The 1870s Pulsometer steam engine (a reworked Savery engine) could cope with water volumes up to 2,500 gallons per minute. By 1900, electric centrifugal pumps surpassed this amount (Church 1986:316).

As water pumping engines were expensive to purchase, as was manning them constantly, water in the mines was an eventuality best avoided with preventative measures. Prior to 1830, methods were in use to keep water outside shafts being sunk. Cast iron tubbing took the place of wooden planking and masonry. The cast iron was installed in segments as sinking progressed, with lead sealing the gaps keeping most of the water from the shaft and workings below.

The Kind Chaudron method, of French origin, combined the process of sinking and tubbing in England in 1877. This method utilized a narrow advance shaft, enlarged by a rotary heading made watertight with a box stuffed with moss. As the sinking progressed, iron tubbing was placed over this to block off watery strata by creating hydrostatic pressure. That procedure was slow and expensive, but a marked advance over existing methods (Church 1986:317).

The problem of reaching coal underlying quicksand was the final advance in boring techniques. Poetsch's freezing technique was first used in 1902, when a series of bore holes were driven through the strata and injected with calcium chloride until the ground was entirely frozen. A variant used ammonia vapor to achieve greater depths. These advances resulted in the sinking of absolutely vertical shafts with few technical difficulties. The mines assumed more permanency and, as a result, the shafts were typically lined from top to bottom with cast iron, stone, or brick by the first decade of the twentieth century (Church 1986:318).

The water that still seeped into the mines was removed by pumping engines housed on the surface. The engines ranged from small, primitive Newcomen-type and Watts engines, to the new, large Cornish and horizontal compound engines. The Newcomen and Watts engines were inexpensive by this time and easy to relocate because they were relatively small. They were, however, restricted in the amount of water they could pump. The Cornish engines were substantial investments of capital for they required large buildings to house the machinery; however, the Cornish engines consumed minimal amounts of fuel and ran more reliably than the previous types. Those were replaced in the last quarter of the nineteenth century by the horizontal compound engines; these were more compact, had smooth, variable speeds of operation, and were less expensive to install. Horizontal compound engines were also used to generate electricity and for winding, and sometimes for both concurrently (Church 1986:318-319).

The engines were housed in various types of buildings to protect them from the elements, for whether expensive or not, the welfare of both miner and mine depended upon them. The Newcomen engines were housed in tall buildings of stone or brick. A tall chimney, built as part of one wall, vented the Newcomen boiler. Boulton and Watts engines arrived with explicit instructions concerning the assemblage of the engine and the engine house. This engine had to be contained in a stone building with a strong "leverwall" to support the "working beam" (Hudson 1976:111). A Cornish engine was housed in a rectangular building with a round chimney at one corner and opposite, a massive bob wall on which the engine beam rocked (Trinder 1982:115).

In an effort to economize further, the pumping engines were transferred to the pit bottoms at the end of the nineteenth century. This arrangement saved the cost of expensive pump rods and engine housing, and also allowed the engine to work continuously on a light load at low cost (Brown 1924:189-191). The application of electricity to pumping in the 1880s further diminished the difficulties. Centrifugal pumps, introduced after 1900, caused widespread use of electricity. They could pump dirty water, were more efficient, and could be linked to electric motors (Pamely 1904:556-564).

After sinking was finished and drainage underway, underground gangways were planned and excavated for haulage, ventilation, and escape. The increased permanency and long life of coal mines in the nineteenth century caused greater concern for adequate roof supports, at a minimal cost. In the past wooden props had been set to support the overlying strata, but they lasted only a short time because of the wet conditions. Brick lining was used as a more permanent solution; however, the brick was more expensive and installation time-consuming. By the end of the nineteenth century gangways were being lined with steel and iron girders (Church 1986:322).

Ventilation was still a major concern in the nineteenth century as the working face of the mine was moved further beneath the surface. Wooden brattice was well established by the 1830s as a method of ventilation. However, the use of furnaces at the pit bottom to create a draft were standard practice in large, deep collieries. The furnace system of ventilation worked well as mines delved deeper, for the large amount of air drawn through the workings increased the furnace's effectiveness (Church 1986:322). Nevertheless, there still remained the inherent danger of explosion if gas reached the furnace flame.

Mechanical fans were a safer means of ventilating the workings. The earliest fan, installed in 1807, did not yet have the capacity for adequate ventilation. When the deep, gassy seams of steam coal were reached during the 1840s, the need for ventilation increased. An air pump, the W.P. Struve ventilator, was successfully installed in 1849, followed by the first Brunton fan. Waddle and Schiele fans were introduced in the 1860s; however, the most popular fan was the Guibal, patented in 1862. These fans became popular, in part, because the use of small coal chunks and coal dust had found an economic market in the coking process. Therefore, instead of using a large amount of former waste coals as fuel for furnaces, fuel-efficient fans were installed. By 1900, even the deepest mines could be ventilated using the faster-running centrifugal fans (Church 1986:323;325).

The methods of extracting coal also helped improve ventilation in the workings. Mining engineers understood that working along the longface of a coal seam facilitated air flow, allowing no gas accumulations in confined spaces or recesses. The substitution of the longwall method for the previously popular pillar-and-stall method took place during the mid-nineteenth century (Galloway 1898:250).

Lighting also improved, unfortunately primarily as a result of several large lamp-caused explosions. The hand-held Davey lamps, first introduced in 1815, had a wire gauze and later a glass shield which kept the flame from igniting any gases (Church 1986:325). However, even a small pin-prick hole in the wire gauze allowed an explosion. Numerous other lamps were invented, with the Davey, Clanny, and Stephenson lamps most popular, but miners complained that none provided as much light as the open flames of candles and paraffin and oil lamps. Legislation in 1911 finally divided mines into groups required legally to use only safety lamps because of their gaseous nature (Church 1986:326-327). The general lighting for pit bottom and gangways was provided by torches in the early nineteenth century, but by the 1850s the use of gas lighting had spread. Electric lights superseded gas light by the first decade of the twentieth century (Church 1986:328). Typically the collieries used a combination of these different lighting devices.

Technical advances, such as increasing use of explosives and the adoption of coal-cutting machinery, increased the productivity of Englands' collieries after the mid-nineteenth century. The increased availability of mechanical cutters allowed the harder seams, previously unmined, to be exploited. The cutters also facilitated the more general use of the longwall method of working the face, as this produced a greater quantity of valuable large coal (Church 1986:340-364).

The increased output required an efficient system of haulage from the working face to the gangways, gangway to pit bottom, and pit bottom to the surface. By the 1830s, most collieries used wheeled trams, or wagons shod with iron rings, rolling along light rails or wooden boards instead of sledges. When the 1842 Mines Act forbid women and young children from working underground, ponies assumed their positions as haulage hands. Electricity enabled limited rope haulage by the 1880s, but it was not generally adopted as it created too much obstruction within the gangways (Church 1986:366).

Once the coal was hauled to the pit bottom, winding it to the surface took place. Like many other aspects of nineteenth-century mining, winding also experienced mechanical advances. By the 1830s, many large collieries required substantial winding plants, and smaller collieries could make-due with simple steam engines (Church 1986:370).

In the Northeast and Lancashire coalfields, large winding engines were employed by the 1840s. These were housed in tall buildings of stone, brick, or sometimes timber, adjacent to the pit head (Trinder 1982:114). The horizontal twin-cylinder engines replaced these by 1870 and compound engines superseded the horizontals by the 1880s. Electric winding did not come into general use until after 1913 (Church 1986:370).

During the eighteenth and early nineteenth centuries, the coal was raised in baskets or tubs, and sometimes wooden corves. By 1830, cages with railed bottoms were adopted, eliminating any additional movement prior to ground transportation. These cages were guided with wire within the shaft to keep from hitting the walls, protecting miners and coal (Church 1986:371-372).

Upon reaching the surface coal was dumped on banks to await final sale. However, most coal required preparation, sorting, and grading before sale depending on the customers' demands. Early in the nineteenth century, there was little preparation necessary, only the size of the coal lump imposed a constraint on marketability as consumers did not differentiate much between coal types (Church 1986:372-373).

The waste, both of small coal and coal left as pillars within mines, ended by the 1870s. Millions of tons of coal had been raised, leaving little choice but to now begin working thinner, dirtier coal seams. In addition, customers had become more particular about what types and sizes of coal they would purchase. The customers were, by the late nineteenth century, primarily industrial rather than domestic and pressured mine owners to process the coal (Church 1986:373). This resulted in greater care taken when grading the coal by size, and especially when removing all dirt from coal to be sold (Church 1986:374).

Again, the Northeast coalfields pioneered screening techniques for the coal industry. Prior to the 1830s, all coal was tipped onto grids of bars 2 cm. apart, which allowed the proper sized "large" coal to remain and extraneous material to be picked out. The remaining coal could either be sold as it was or further screened over 3/8 of an inch bars, producing "nut" or small coals. The coal that passed through this screening was generally unsaleable. This coal could be consumed as colliery equipment fuel, miners's coal, or returned underground for replacing mined coal pillars or mending roadways (Church 1986:376).

A.H. Leach (1886:15), colliery manager at Wigan, stated that: "The good old times, when almost anything that looked black would sell, had passed away and complaints of dirty coal are now one of the ills which every colliery manager had, more or less, to bear." A coal-crushing and washing plant was constructed at William Baird's collieries in the 1870s, and Brinsop Hall collieries had belts of steel wire that carried coal on to a moving screen, while the waste fell through on to a chute and into a wagon (Leach

1886:95). It was generally held that screening and washing coal techniques had advanced more in the 1880s "than...any department of management" (Colliery Guardian 1890:258).

Another area of major improvements during the nineteenth century involved the coking process. In 1830, only large coal was used to make coke in open heaps or open-topped brick boxes, with a central brick chimney to provide a draught. As large coal already was of prime market value, colliery owners looked for a way to coke small, less valuable coals, thereby increasing the profitability of mining. By the 1840s, this technical difficulty was overcome and ovens dotted the landscape in Durham, coking small coal for the railway market and later the iron industries (Church 1986:378-379). The ability to coke small coal and coal dust enabled many collieries to survive depressed or seasonal markets (Royal Commission Coal Supplies 1903:4932-4933).

Coking technology underwent a period growth between 1845 and 1873, including the caking of small coal into briquettes and the deliberate crushing of large coal for coking (Dunn 1852:327). The coking ovens became standard circular brick ovens with sloping floors and with trough washers to reduce the dirt content before coking (Steavenson 1859-60:109-135). Ovens were also designed to recover valuable coking by-products, particularly from long, tall, narrow ovens with side flues and beehive ovens (Mott 1936:55-56;61-63). The older beehive ovens did not allow easy recovery of by-products, and so dropped steadily in popularity from 80% use in 1900 to 40% in 1913 (Mott 1936:55).

Nineteenth-century improvements in miners' housing corresponded to the coal industry's increasing need for a steady work force, with housing provided to "sweeten the pot." Nearly all miners were housed in brick or stone houses by the mid-nineteenth century (with the exception of Scotland, which lagged deplorably behind in housing conditions). Those houses offered improvements in space and sanitary conditions over those constructed during the previous century. If collieries did not provide housing, miners often rented rooms from private individuals; however, a growing number of miners were forming "building clubs" which pooled savings and contracted the construction of multiple family rowhouses. After construction, the miner assumed the mortgage and became a member of the home-owning class in Britain (Church 1986:602).

The miners began to construct new multiple and also single-family houses with roomier dimensions than the typical one-story houses of the eighteenth century. The period between 1860 and 1870 was favorable inclined towards the construction of more adequate housing (Church 1986:608). However, after 1880 critical housing comments, typical of those voiced in the preceding centuries, reemerged. They were, perhaps, a result of increased social awareness rather than any marked deterioration or abnormal (for the period) overcrowding. This is not to say mining communities were models of hygiene and health. Mining villages still suffered from deficiencies common to rural housing in general; however, circumstances had improved measurably (Church 1986:608-609). Some collieries constructed "model" villages for their workers, with garden plots for each cottage, privies, cricket fields, schools, and "collier boys...in the streets singing and whistling the beautiful airs from Handel, Haydn, Mozart, and Spohr" (The Arkwright Society 1975).

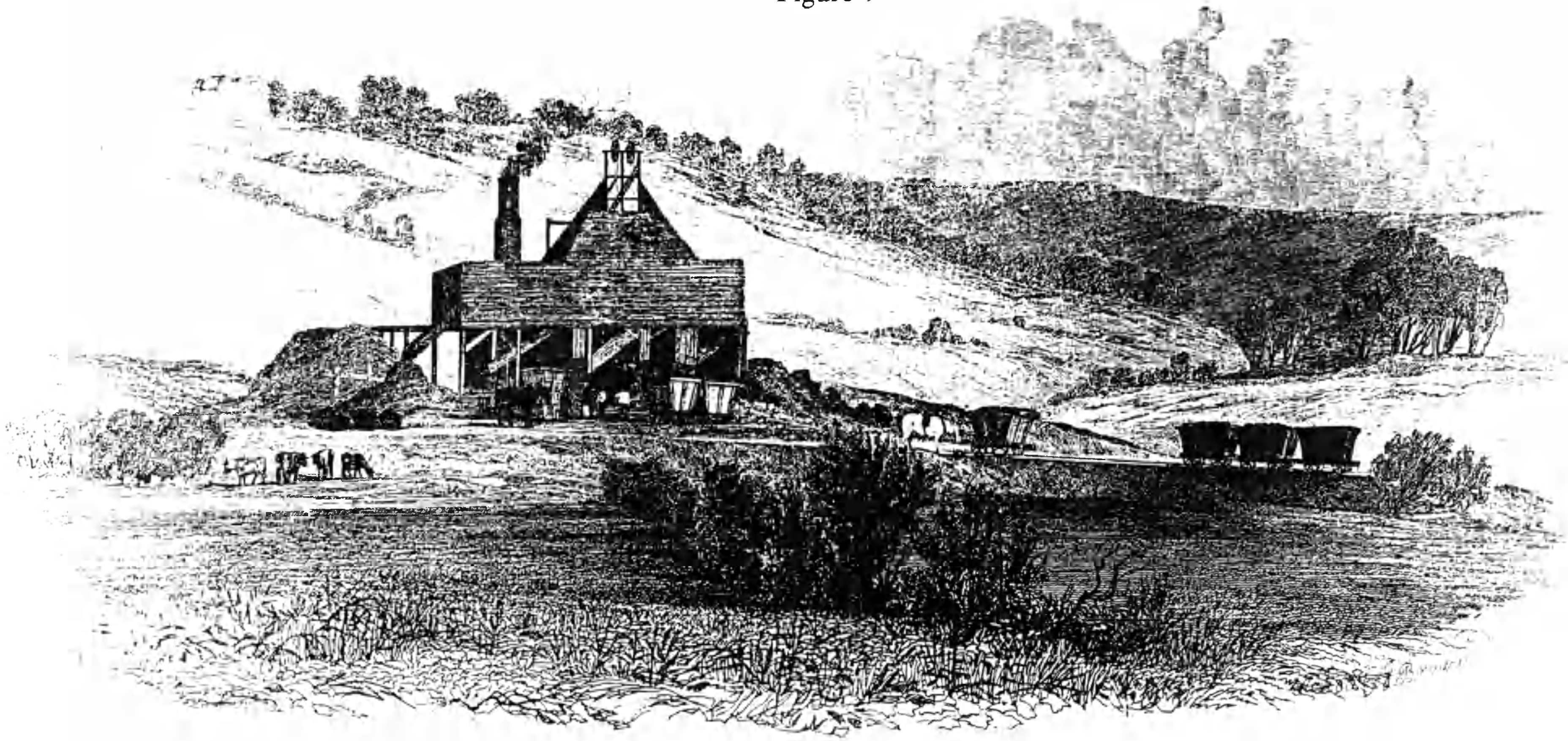
When new mines, without housing established, opened some distance from an established village, miners would walk long distances for employment. To entice colliers, weekly lodging in barracks or lodge shops was provided. This dormitory-style buildings were plain sandstone, 18 feet by 15 feet, with one door and two windows on one side, and a large fireplace. Up to 48 miners could stay in one building, with beds situated under the sloping roof (Trinder 1982:189-190). Villages could expand with the barracks as the nucleus, if the mine stayed open for any length of time.

The more intensive and steady development of the nineteenth-century collieries resulted in gradual changes in the landscape surrounding the pits. Large piles, or "tailings," of shale and other waste built up near the pit head and processing buildings. Iron railway tracks criss-crossed the sites, and engine and other machinery housings dotted the region (Figures 9, 10, and 11). Buildings such as lamphouses, machine shops, blacksmith and carpentry shops, company stores, offices, and in the late nineteenth century pithead bath houses, covered colliery landscapes (Raistrick 1972:53-54). Thus, by the early twentieth century, the English landscape surrounding mines spread outward in concentric circles away from the mine shafts. As the circles advanced outward, the importance to actual mining decreased and became supportive, or dependent features of the colliery.

Summary

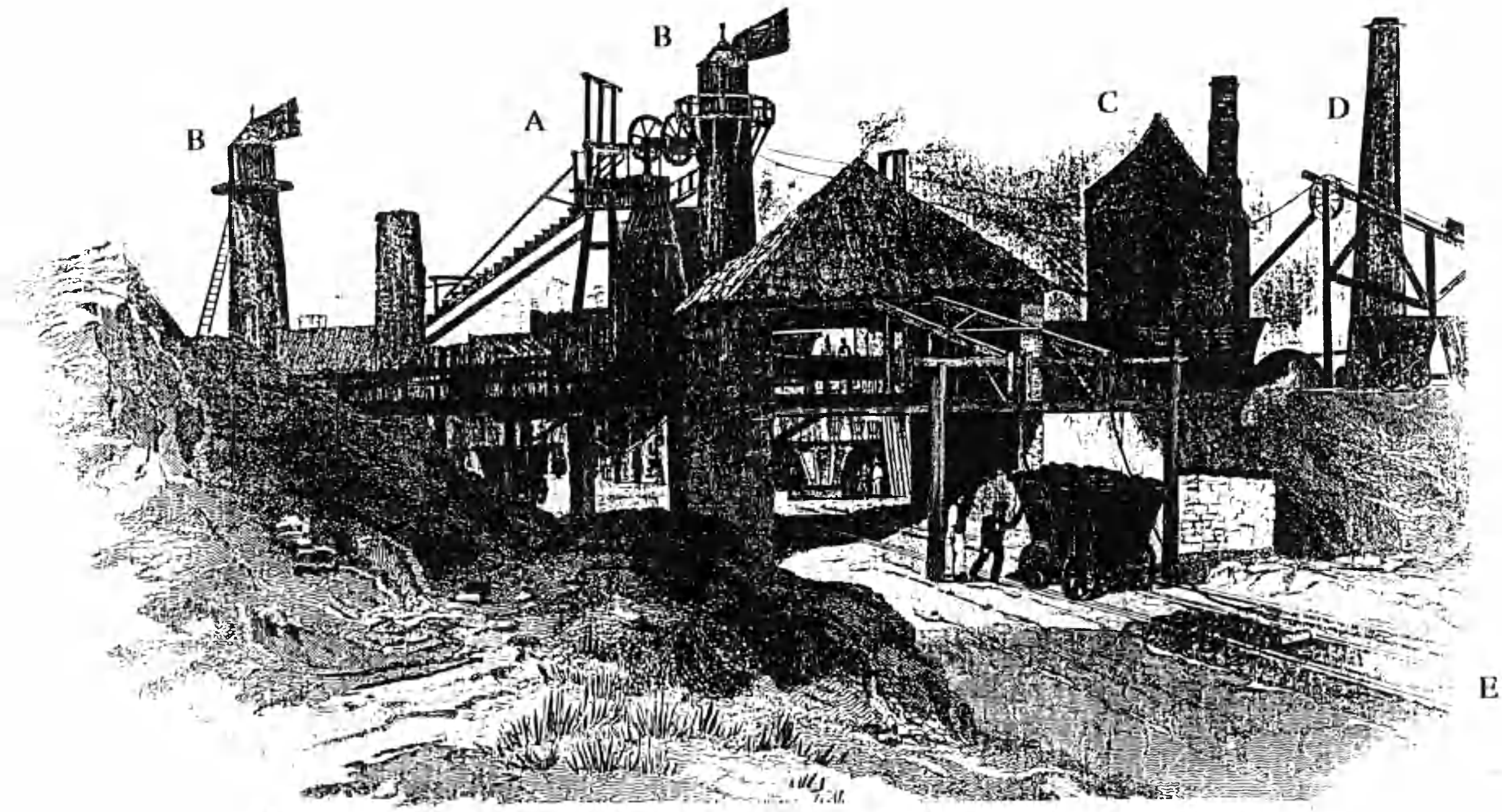
The earliest use of outcropping coal in England occurred during the period of Roman occupation. However, it was not actively exploited until several hundred years later during the late twelfth century and especially the thirteenth century. During the

Figure 9



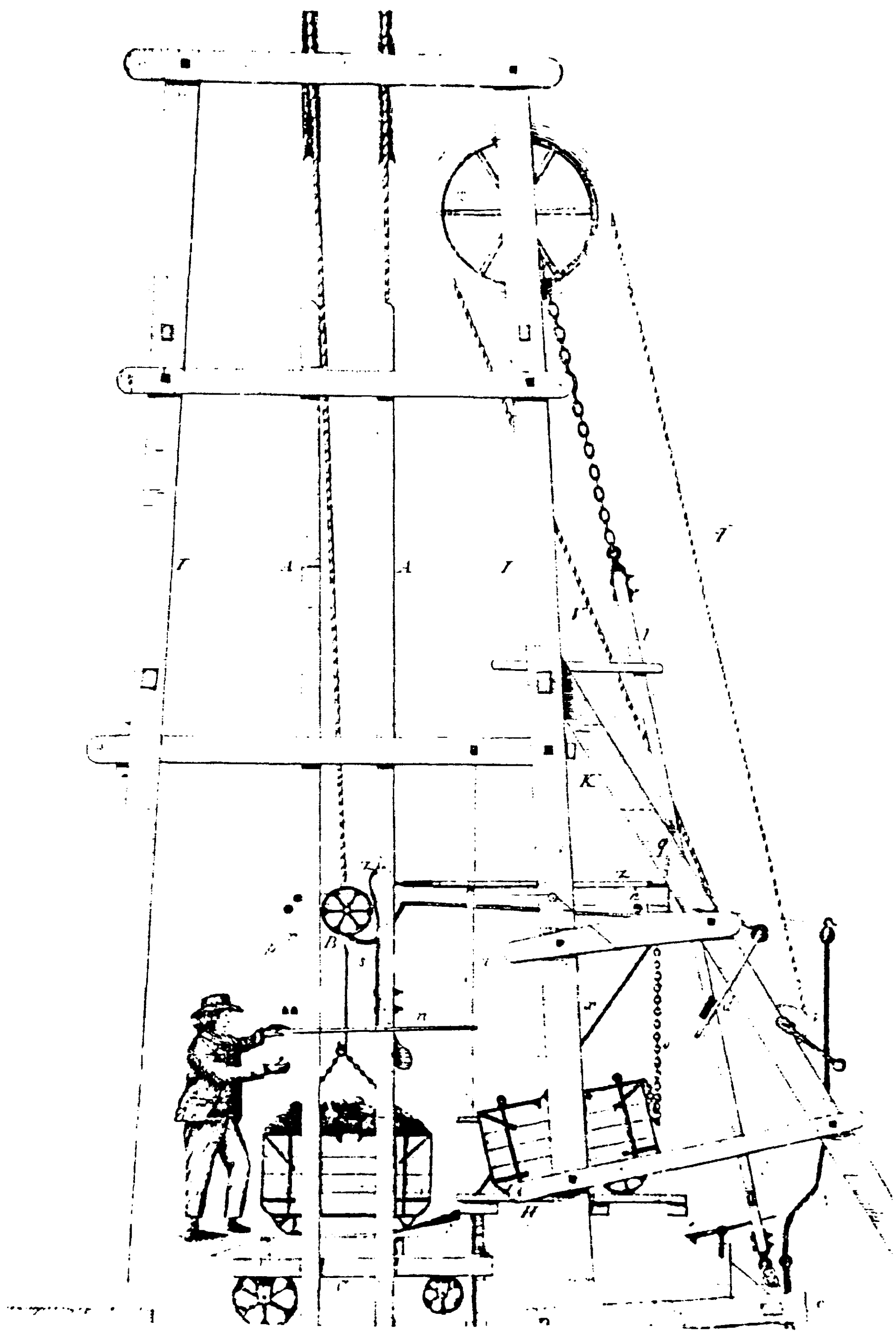
Garesfield Colliery in the Northeast coalfield of England. Note the coal tramway in the foreground (After Hair 1839).

Figure 10



Mid-nineteenth century view of the Church Pit Wallsend colliery, in the North-east coalfield. A. Shaft frame or "pithead gear" situated directly over the shaft; B. Upcast shaft with brick chimney for ventilation; C. Engine housing containing steam machinery for winding; D. Chimney for boilers; E. Incline railway (After Hair 1844).

Figure 11



Pithead gear designed by Curr in 1789. Similar to the pithead gear visible in Figure 9 (After Curr 1789).

thirteenth century, there were numerous references to coal obtained all across the countryside from the surface outcrops. "Sea cole" was also obtained along the North Sea, where it was eroded onto the beach by wave action. The first reference to the actual mining of coal is dated 1243, and it indicates that colliers were moving beyond the surface extraction of coal, to digging trenches and shallow pits into the coal seams.

In the fifteenth and sixteenth centuries, the English environment was under a severe strain from the rapidly expanding human population. The supply of timber in particular had dwindled to virtually nothing after centuries of use for heating and building. This shortage pushed a reluctant country toward another available resource, namely coal. By 1590, instead of simply being obtained by farmers to heat their homes, the use of coal had expanded to various trades across England.

The early collieries, located away from natural waterways, were smaller during this period because of transportation difficulties. However, despite their small size, there were larger numbers of these "land-sale" collieries, which supplied local domestic consumers and some tradesmen. The smaller collieries mined shallow bell-pits and trenches into the coal seams. The circular bell-pits were excavated to approximately 20 feet in depth, with the coal surrounding the bottom of the pit extracted until the danger of collapse became too great. A new pit opened nearby would subsequently fill the neighboring worked-out bell-pit. Prior to the sixteenth century, bell-pits were accessed by ladders; however, by the beginning of the sixteenth century, "Jack rollers" (small wooden windlasses) were used to access slightly deeper pits.

The increased demand for coal during this period encouraged the growth of coal mining as an infant industry. The larger collieries developed along natural waterways, and these mines provided coal for the sea-sale markets in Newcastle, London, and foreign ports. The larger collieries began to expand outward underground to extract the coal. The colliers began to work with set mining patterns, such as the pillar and bord system; on the surface, hoisting equipment included horse gins attached to pithead winding gear to raise coal, men, and water from greater depths.

Technological advances during this time period determined the extent, or depth, to which mining could proceed, and once that limit had been reached, mining had to expand on a horizontal plane rather than a vertical one. Just as technology enabled, or forced, the English to accept coal as a substitute for timber, so too did technology allow the gradual expansion of the coal industry. This pattern of technological advances and colliery expansion increased greatly during the eighteenth century, and especially the nineteenth century, in the midst of the English Industrial Revolution.

Eighteenth-century England contained an ideal social setting for the coal industry's expansion, for there were affluent mine owners who joined forces with the businessmen and industrialists (the emerging middle class), to meet rising capital demands. The capital allowed mine owners to purchase innovative equipment to obtain larger amounts of coal from greater depths, as well as employ larger numbers of colliers. The landless squatters (the lower class) comprised the necessary labor force to make the expansion a successful reality.

Serious technical problems, such as drainage and ventilation, plagued eighteenth-century mining. Gradually, the work of inventors like Savery and Newcomen lessened the drainage problems with engines for pumping out mine water. The ventilation problem was not adequately solved until the early nineteenth century; however, wooden or brick air shafts with coal fires at their base enabled some fresh air into the deeper mine workings.

Nevertheless, the eighteenth-century improvements in drainage and ventilation allowed the extraction of coal at greater depths. The hoisting technology had not keep pace with the other innovations, as the cog-and-rung gins and horse gins could not provide power necessary to bring the deeper lying coal to the surface. However, the early steam engines for pumping were gradually adapted to winding, and by the late eighteenth century, steam-powered winding engines were in use in the Northeast collieries. As these pieces of equipment were more costly than the wooden animal-powered winding gear, permanent structures of brick and stone were built to house the engines. At this point, it was more economically prudent to invest time and money into deeper mining rather than opening new mines. Technological advances served to make the collieries more settled areas, instead of the previous cycle of "boom and bust" with bell-pits opening and closing rapidly.

Mining as an occupation became more specialized during the eighteenth century. Individuals were trained to fulfill specific tasks, rather than the one-pit to one miner philosophy of the previous centuries. The work force inside the mines was predominately male, with young boys and sometimes girls, working at less important jobs rather than doing the actual mining. The specialization trend forced the collieries to go to greater lengths to retain the experienced colliers, and so housing was provided by collieries in the mid-eighteenth century. These were typically two-story rowhouses of brick or stone located near the colliery. By the late eighteenth century, mining communities emerged with churches, social groups, company stores, and trade unions.

Transportation problems inhibited early eighteenth-century mining, as overland transport was difficult and expensive, with navigable waterways available only at some fortunate collieries. In the mid-eighteenth century, iron-covered wooden wagonways improved overland travel. The roads and especially canals, opened across the English countryside during this period.

By the nineteenth century, the technical advances in mining and innovations in coal's use as a fuel caused coal mining to become one of England's leading industries. Advances in winding, ventilation, and drainage came about as a result of the widespread adoption of steam engines. There was also progress made in safer forms of lighting the gaseous mines. These technological advances served to contribute both towards satisfying increased consumer demand and the continuing expansion of the coal industry.

The accumulated knowledge of the preceding centuries gave the nineteenth-century colliery owners and colliers a better understanding of the geologic conditions in which they mined. This understanding also helped improve the safety conditions in mines, and made them lucrative investments for businessmen, especially iron masters. In many cases, iron masters saw the economic advantages in either a partnership with a colliery owner, or the outright ownership of their own colliery as a supportive feature to their ironworks. Many English ironworks had their fuel supply problems solved by opening adjacent collieries.

Early nineteenth-century improvements in transportation changed the character of the English coalfields, as previously inaccessible, and therefore, unmined areas were opened by railways. The construction of railways was the technological key that fully allowed the exploitation of English coal resources. This transportation improvement also caused a subsequent expansion of collieries across the whole of England. Until the 1880s, England experienced almost continual growth at collieries, both in the amount of coal extracted and in the number of new collieries opened.

Two major technological improvements in coal mining "access" technology and "operational" methods occurred during the nineteenth century. The access technology enabled the colliers to work in safer conditions, and operational methods involved planning mine working layouts, obtaining the coal, and transporting it to the ground surface. The surface preparation of the coal also improved with sorting and cleaning.

Thus, during the nineteenth century, and into the early twentieth century, a tendency visible on the English landscape was toward greater long-term stability and permanence at collieries. This economic trend is reflected in the increased number of industrial buildings, as well as supportive structures, located on the industrial landscape of the period. By the early twentieth century, the English landscape surrounding collieries spread outward, with important mining-related structures situated close to the pithead, and supportive structures, such as miners' houses, churches, schools, company stores and offices located farther away from the pithead.

Beginning in the thirteenth century and ending in the early twentieth century, the general trend in English coal mining changed from a necessary fuel-gathering task in an agrarian setting, to self-sufficient mining communities on an industrial landscape. Mining of a natural resource in the English environment was directly influenced by, and also influenced, various technological advances through time. The technological advances caused significant changes in the social structure of England during these centuries, with English culture undergoing the social, economic, and political transformations associated with the Industrial Revolution.

CHAPTER IV

HISTORY OF THE RICHMOND COALFIELD

Introduction

This chapter will provide the necessary historical background for the development of the Richmond, Virginia coalfield, as well as the social context in which the coal mining took place. The history of the Richmond coalfield is divided into three periods, which are based on social and technological occurrences which had significant impact on the coalfield's development. The mining techniques used during each period, both above and below ground, are also discussed. The first period, 1701 to 1794, covers the modest beginnings of coal mining to the economic boost the industry received in 1794 from an import tariff on foreign goods, which included coal. The second period, 1794 to 1850, encompasses the expansion of the coal industry after the 1794 tariff to the peak of production within the coalfield. The final period, 1850 to 1939, includes the decline of the coal industry, with a short-lived resurgence during the Civil War, and the eventual closing of the coalfield due to increased availibility of better quality anthracite coal from southwest Virginia, West Virginia, and Pennsylvania.

Richmond Coal Mining History:1701-1794

The presence of bituminous coal in Virginia was first documented by Col. William Byrd in a letter to the Colonial Council of Virginia dated May 10 and 11, 1701:

> The 10th of May, last, I with Coll. Randolph, Capt. Eppes, Capt. Webb, &c., went up to the new settlement of ye ffrench Refugees at ye Manakan Town....We went up to ye cole, w'ch is not above a mile and a half from their settlement on the great upper Creeke, w'ch, rising very high in great Rains, hath washed away the Banke that the cole lyes bare, otherwise it's very deep in the Earth, the land being very high and near the surface in plenty of Slate (Virginia Historical Society Collections Vol. 5 n.d.:43).

The French Huguenots, religious refugees, had been given a large tract of land on which to settle in 1699, located about 14 miles above Richmond, Virginia. Tradition has it that coal was discovered there when a hunter, chasing a deer, pulled a small tree from a steep bank near a stream, exposing the coal beneath the ground (Eavenson 1942:29). Col. Byrd's letter referred to the Huguenot settlers using coal for domestic heating and cooking in grates, and it is likely they had been doing so prior to Byrd's letter of 1701 (Brock 1886). These settlers probably obtained coal found in outcrops, as they undoubtedly had in their native France. By 1702, David Menestrier, a blacksmith "and one of ye french Refugees," petitioned for the right to use coal from these pits in his forge (Virginia Council Journal 1776-1783).

Col. Byrd realized the monetary potential of the coal and patented 344 acres of coal land on October 20, 1704, and an additional 385 acres (Sabot Island) on November 2, 1705 (Wright and Tinling 1941:48). By 1709, Byrd claimed "...that the coaler found the coal mine very good and sufficient to furnish several generations" (Virginia Historical Society Collections Vol. 5:43). In 1710, George Smith, "the coaler," informed Byrd that all was well at his Sabot mines (Wright and Tinling 1941:48).

William Byrd was not the only English colonist of foresight. An Englishman visiting Virginia in 1704 or 1705 wrote to fellow entrepreneurs:

> And I assure you, Gentlemen, the best, richest, and most healthy part of your country is yet to be inhabited, above the Falls of every river, to the Mountains, where are several advantages not yet generally known, as sea coal, lately discovered near the French Settlement, above the falls James River (Anonymous 1705:257).

Robert Beverly (1722), however, held little hope for the coal industry in Virginia. He wrote of coal existing in the "upper parts" of the colony, but thought that it would only prove useful in "forges and great Towns, if ever they happen to have any." Indeed, due to a restricted local market and competition from foreign coal, the Richmond mines produced less than 1,000 tons of coal annually during most of the eighteenth century (Wilkes 1988:6). Nevertheless, time and circumstances would prove skeptics such as Beverly wrong.

As the new countryside was being explored and mapped, mineral deposits continued to be described. In 1724, chaplain Hugh Jones (1724) noted that in Virginia:

> in several Places is Coal enough near the Surface of the Earth; and undoubtedly in Time they will either have Occasion or Vent for it, to supply other Places, if they will not use it themselves; but if Coal Works were there carried on to Advantage, New Castle may witness, what Numbers of Ships and People are employed in such Affairs, and what vast Profit accrues from thence.

Jones had noted the similarity between the coal industry in England and that in the burgeoning colony of Virginia.

While there have been reports of coal mined near Midlothian in the 1730s, these are as yet unsubstantiated. Coal was also reportedly mined in the Manakin area during the 1740s and 1750s (Agee 1962:77). The first historic document with a reference to the actual mining of coal in the Richmond coalfield is found in John Brummall's will dated February 6, 1746. He left "half of the Track of land lying and being at a place cald the Cole Pit," which was located on the headwaters of Falling Creek, to his wife Sarah (Henrico County Will/Deed Book 1744-1748:378). Brummall's use of the term "pit" indicates that coal was actually being extracted, as opposed to the word "mine," which meant, during the eighteenth century, a deposit or outcropping of coal. For example, Joseph Scott wrote in ***The United States Gazetteer*** in 1795, that in Henrico County "a number of coal mines are in the county, and pits have been opened by many proprietors." That terminology would change by the mid-nineteenth century, when "mine" became the modern term used to describe a large colliery, or a number of working pits or shafts.

In Chesterfield, Henrico, Goochland, and Powhatan counties, there emerged in the eighteenth and nineteenth centuries mine owners who distinguished themselves in their chosen profession. Those individuals included Harry Heth of Black Heath, Martin and John Railey of Railey's Pits, Thompson Blunt of Blunt's Pits, the Wooldridge family of Wooldridge's Pits and the Midlothian Coal Mining Company pits, and Samuel DuVal of the Deep Run Pits.

In 1760, Samuel DuVal, began extracting coal from a pit on the Deep Run road to Richmond (in Henrico County) (Eavenson 1942:35). DuVal had ten workers to excavate coal from shallow pits. The coal was then piled next to the road and loaded into wagons for the trip to Richmond (Manarin and Dowdy 1984:116). On June 3, 1766 in the ***Virginia Gazette***, DuVal advertised his coal "to be sold at Rockit's landing,...any quality of COAL for 12d. a bushel, not inferior to the New castle coal...." The Deep Run Pits operated during the Revolution and supplied coal to the Westham Foundry between the years 1777 to 1780 (Westham Foundry Accounts 1777-1780). DuVal also sold 2,781 bushels of coal to the Pennsylvania Committee of Safety (Manarin and Dowdy 1984:116). By 1780, DuVal offered the Deep Run Pits for sale, praising his "valuable coal pits and their coal judged to be superior to that of New Castle" (***Virginia Gazette*** September 20, 1780.)

Samuel DuVal owned several tracts of land in the Richmond area, and in 1779, sold to his sons, William and Samuel, Jr., one half of a 100 acre tract lying on Falling Creek in Chesterfield County. This tract came with title to "all Coalpits, Minerals, Mines, houses, orchards, and Gardens" (Chesterfield County Deed Book 1778-79 No.9:104). The increased attention focused on Richmond coal mines and pits made purchases such as this all the more valuable.

Thomas Jefferson (1781:47) apparently believed this attention to be well placed because he mentions the Richmond, Virginia coal resources in his Notes on Virginia:

> Pit coal. The country on James river, from 15 to 20 miles above Richmond, and for several miles northward and southward, is replete with mineral coal of a very excellent quality. Being in the hands of many proprietors, pits have been opened, and before the interruption of our commerce, were worked to an extent equal to the demand....

In 1781, Jefferson, then Governor of Virginia, lamented the Continental Congresses' request for "14,492 hard dollars" to pay the debts of American prisoners in New York when he wrote that if produce was acceptable, it would cost considerably less than the "hard dollars." He particularly felt that Virginia coal would "do neither good to the enemy nor injury to us" if it were included as produce (Ford 1892:446-447).

In 1786, coal deposits were discovered in the Tuckahoe Valley area in Henrico County. Both coal and natural coke were available to Col. Thomas Randolph, who had the pits worked as DuVal did at Deep Run. Tuckahoe Creek was dammed to maintain its water level, and coal was loaded into bateaux for the trip down the creek, and on the James River to Richmond docks (Bladen n.d:1). During this period, William Cottrell, John Wickham, and John Ellis also opened pits in this area (Manarin and Dowdy 1984:189).

Although there are no accurate figures for this period, it is estimated that 400 tons of coal was extracted from mines opened in Chesterfield and Henrico counties in 1786. That figure remained roughly constant until 1793. The majority of the coal was destined to heat homes in household grates (Manarin and Dowdy 1984:189-190).

At the close of the Revolutionary War, Dr. Johann Schoepf traveled throughout parts of the new country. In Virginia, he visited the mines in the Midlothian area where:

> There has been discovered a bed of pitcoals 12 miles from here [Richmond], on the south side of the James River and above the falls, the occasion of discovery being the uprooting of a tree by the wind. The region is low, and it is probable that the bed was formed from the plant-earth choked up behind the falls. Four feet below the surface there is a white clay-slate. Next a blacker clay and then the coals. Trenches are dug straight down, and at 26-30 feet the bed is not yet gone through; these trenches soon filling with water, new ones are continually opened up, although this labor might be avoided. The coals, however, are not the best; all Richmond smells from them. They are sold at the river for 1 shill. Virginia Current the bushel (Schoepf 1788:67-68).

One coal pit operation in the Midlothian area was controlled by Henry Heth Jr. Henry, or "Harry" Heth Jr. was also the founder of the family plantation in Chesterfield County, known as "Black Heath." Black Heath mansion was located about one-and-one-half miles northeast of Coalfield, or present day Midlothian, Virginia. That two-story Georgian structure was probably built in the last quarter of the eighteenth century (O'Dell 1983:89). This rambling mansion was later to be a victim of the industry which helped create and maintain it (during the early twentieth century it was abandoned after the foundation began subsiding into the mine workings below).

Heth opened the Black Heath Mines in 1788 (Morrison 1974:xiv; Eavenson 1942:41). As the coal seams outcrop in the Black Heath area, it is possible that Heth excavated shallow pits for coal before 1788. However, the work done after 1788 was extensive. Nevertheless, when a part of the old workings caught fire in the 1790s, the shaft was filled up, and the operation listed for sale in 1795 (Grammer 1819:127; Eavenson 1942:41). Apparently, the business had not been as profitable as anticipated.

Both during and after the Revolutionary War, the Richmond coalfield experienced a rise in output from existing pits and mines, as well as new ones being opened. This expansion was, in part, due to the increased attention focused on becoming less dependent on foreign goods, such as coal. In 1790, 181,385 bushels of coal were imported, but in 1791, 3,788 bushels were exported from the United States, and in the following year, 13,023 bushels were exported (Coxe 1794:180-181, 402,405). The creation of an import tariff in 1794 further aided the Richmond mines by allowing expansion without foreign competition. The 1794 import tariff imposed on foreign coal furthered the financial position of the Richmond coalfields, enabling them to invest in improvements such as construction of canals and turnpikes in the subsequent period of mining.

Mining Techniques: 1701-1794

When coal was first being extracted from the Richmond basin, English coal mines had been operating for several centuries. English standards of safety, and mining techniques were, by virtue of experience, more advanced. In contrast, during the eighteenth century, mining in the Richmond coal basin was, for the most part, undertaken by semi-skilled or completely unskilled workers.

The first period of mining, 1701 to 1794, was primarily surface extraction. Coal was dug from outcrops visible on the ground surface. The coal from these shallow pits (20-25 feet deep) was used for domestic purposes. The shallow pits were probably identical to the English bell-pits of the twelfth century through the sixteenth century.

These shallow pits were also used to obtain subsurface information during exploration before deeper shafts were sunk (Wilkes 1988:10). As there were no forms of chemical testing, coal quality and geologic conditions could not be anticipated prior to mining, resulting in "blind" mining. The bell-pits alleviated some of these problems.

Trenches were excavated along a coal seam discovered in a shallow pit. The trenches followed the coal seam until the overburden of discarded soil, shale, and slate became too thick and the trench too deep. The trenches may or may not have obliterated the earlier pits.

The technique of pit mining led to the excavation of inclining slopes or drift mines. The excavation followed the coal seam as it dipped steeply farther into the ground. Often the drifts or slopes were place on hillsides where coal was exposed. Larger slopes were dug 100 or 200 feet down dip. Eventually, when all minable coal had been taken, levels or "gangways" were extended from a slope to follow coal seams or pockets. The geology of the Richmond basin is such that no two mine "plans" were alike because of the local rolls, dikes, and faulting of the coal seams (Wilkes 1988:9).

By the mid-to late eighteenth century, vertical mine shafts were being sunk until deeper lying coal seams were struck. Shafts were excavated by shovels and handpicks until coal was reached, and then shored up with timbers or sometimes brick. Pithead gear for hoisting coal, water, and men was erected directly over the shaft opening. Mines of this period occasionally used older slope workings as escapeways, ventilation, and haulage tunnels. However, typically the shafts were excavated well away from the older slopes because of the danger of flooding or deadly gases entering the new workings.

The coal, once extracted from the mine, was dumped on a coal bank, where it was roughly separated from the waste material, such as slate and shale. Then the coal was loaded with little or no sorting of the coal, by size, before its sale. Any waste rock was left in piles, called "tailings." The longer a mine was in operation the larger or more numerous the tailings.

The coal was removed from the mine area by small cars on wooden tracks, or along wagon paths (Roberts 1928:115). All mines needed some sort of access roads that connected the pits to the closest road or waterway. Without those roads, mining would never have been profitable. The coal was then next loaded into either bateaux for water transport, or wagons for over-land transportation to the Richmond market.

The eighteenth-century pits, trenches, slopes, drifts, and shafts were excavated primarily by male slaves, with white overseers. Buildings for shelter were provided for the slaves, as well as food and clothing, during their periods of mining. One or one-and-one-half story log or frame houses would be built for small families, as well as barracks-type buildings for single or less-permanent slaves. Cooks were also employed to feed the colliers, and, therefore, a kitchen building would have been constructed. The overseers employed by the company were also housed near the mine operations. The company size and available capital played a large role in determining the number of slaves and overseers, and, therefore, the number of houses and other mining-related structures that would be constructed at the mine site. The economic status of the mine owner and the availability of capital are strong variables in calculating the types and numbers of structures and equipment at each mine site during the end of this period, and especially during the succeeding periods.

Richmond Coal Mining History:1794-1850

Tench Coxe, a Pennsylvania economist and Assistant Secretary of the U.S. Treasury, had predicted that foreign coal would relinquish it's hold on the American coal market (Coxe 1794:180-181). Coxe realized the future role of coal and manufacturing in the United States, and his remarks are one of the best references to the growing late eighteenth-century Richmond coalfield:

> So many of the necessary and convenient arts and trades depend upon the plenty and cheapness of fuel, that it appears proper to take notice of this article. Till the revolution, our dependence was almost entirely upon wood fuel, of which, in the most populous places, we have still a great abundance, and in all interior situations immense quantities: but the increase of manufactures has occasioned us to turn our attention to coal.
>
> All our coal has hitherto been accidently found on the surface of the earth, or discovered in the digging of common cellars or wells; so that when our wood-fuel shall become scarce, and the European methods of boring shall be skillfully pursued, there can be no doubt of our finding it in many other places. At present, the ballasting of ships from coal countries abroad, and the coal mines in Virginia, which lie convenient to ship-navigation, occasion a good deal of coal to be brought to the Philadelphia market. From this great abundance and variety of fuel, it results, that Pennsylvania, and the United States in general, are well suited to all manufactories which are effected by fire, such as furnaces, foundries, forges, glass-houses, breweries, distilleries, steelworks, smiths' shops pot ash works, sugar and other refineries, &c &c.
>
> The collieries on James river will not only abundantly supply the extensive territory watered by the rivers of the Chesapeake and by that bay itself; but they promise to afford a very valuable nursery for seamen in the transportation of their contents to all the sea-ports of the United States. They already furnish coal on terms much lower than the minimum of the

> first cost and charges of importation; and as labour is declining in price and a short water communication, between the mines and the shipping place is nearly completed, there is no doubt that foreign coal will be rendered a very losing commodity, and that it must finally be excluded from our markets. The interior country is plentifully supplied by nature with this valuable fossil.
>
> The owners of the coal mines of Virginia, enjoy the monopoly of all the supplies for the manufacturers of the more northern states, who live in the sea ports; a demand which is increasing rapidly (Coxe 1794:70-71, 180-181,196).

The increase in coal production after the 1794 tariff was expedited by several factors. One of the most important factors was an increase in the number of slaves used as "hands for the pitts" (Morris Papers 1797-1798). By the time of Gabriel's Insurrection in 1800, 500 followers worked at the Chesterfield coal pits (Lutz 1954:149). These collier slaves were either purchased outright by the pit owner, or hired, or "leased," by contract between the pit owner and the slave owner. The latter arrangement was probably preferred as the contract most often required clothing, food, and shelter for the slave during the lease period. This was usually the case for extended contracts. It is therefore not surprising that between 1798 and 1800, the rate of hire rose steadily from £19 to £20 for slaves (Eavenson 1942:62).

The use of slave labor during the eighteenth and nineteenth centuries proved a boon for plantation owners as well as mine owners. There were often slack periods on Virginia plantations and farms, and income earned by renting out slaves not only provided cash but also temporarily relieved the owner of the cost of feeding and clothing his slaves. The mines also offered ready markets for the sale of farm produce, thus trips to the Richmond markets could be avoided. Those could be enormous burdens for plantations and farms already showing signs of a "systems breakdown" (Channing 1905:390). It also helped generate and retain capital within the Richmond area.

One of the earliest mines in the Richmond basin, the Dover Pits (Goochland County), depended primarily on slave labor. During the Duc de La Rouchefoucault Liancourt's visit to the Dover mines in 1796, he noted about 500 black slaves laboring around and in the pits (Duc de La Rouchefoucault Liancourt 1799:122-125). This labor situation was standard for the Richmond basin mines, and blacks continued working in the mines long after their emancipation.

Improved transportation for the coal from pit head to Richmond also helped increase coal output during this period. Water travel along the James River was improved with the construction of a canal around the falls in 1794. This was the beginning of what would later be known as the James River and Kanawha Canal, which was completed in 1795 (Manarin and Dowdy 1984:176). Canal boats, or bateaux, capable of carrying eight tons, transported coal from Westham to Shockhoe Hill in Richmond. As the Kanawah canal ended one-and-one-half miles away from tidewater, the coal was carried over land by wagon to the port of Richmond (Bruce 1968:92-93). However, Benjamin Latrobe commented that "with all its expense of waggons, horses, and drivers, and consequent waste of labor, capital, food, and forage" the Manchester turnpike was still a better and cheaper method of transport than the canal (Gallatin 1808:89). This remark was based on the never ending difficulties of maintaining sufficient water levels within canals. Often the canals had either flood-conditions, or no water at all, making travel impossible in either case.

Overland transportation was also improved with the construction of solidly built turnpikes. Turnpike roads were built specifically to service coal pits, such as the road that connected the Deep Run Coal Pits to Richmond (Manarin and Dowdy 1984:180). By the time of the 1800 Census, the residents of Chesterfield, and probably other counties, were clamoring for additional highways to get their coal to market (Lutz 1954:149). Existing eighteenth-century roads were often rendered impassable during wet seasons, and even in good conditions they could only support 40 to 50 bushels of coal in each wagon. The new turnpikes were constructed to carry up to 100 bushels of coal without damage to the roadbed. In 1804, the Richmond Turnpike Company was established, which charged a toll on each coal wagon (Manarin and Dowdy 1984:443). It was the construction of companies such as the Richmond Turnpike Company and the Manchester and Falling Creek Turnpike company, and their turnpikes that allowed further expansion of the coalfield.

Virginians were well aware of the commerical potential of coal and began to increase their efforts to produce coal. The result was that by 1800, a mining community called "Coalfield" (present Midlothian, Virginia), 12 miles west of Richmond, was inhabited by 200 or more miners, who with their families, constituted a population several times that size (O'Dell 1983:7). The concentration of a mining community adjacent to the mines increased the general efficiency of the local coal mining efforts.

Early Coalfield consisted of numerous dwellings for miners and their families, at least one tavern and stage coach stop (owned by the Wooldridge family), and possibly a store. This mining settlement was situated on either side of Buckingham Road

(Midlothian Turnpike, Route 60), with the majority of the population located to the east of the present village, along a one-and-one-half- mile long axis stretching from the Railey pits on the southwest, to Black Heath pits on the north, and Trabue's Tavern on the east (O'Dell 1983:83).

The late eighteenth-century domestic dwellings occupied by the miners were probably all of frame or log construction, with brick or stone chimneys and sometimes foundations. These houses were generally only one or one-and-one-half stories high, after their English counterparts (O'Dell 1983:xv). The lifespan of the structures was predictably brief in the humid, insect-laden climate. Thomas Jefferson (1787) felt it was "...impossible to devise things...more perishable. [The] duration of a frame or log structure is highly estimated at 50 years." Therefore, it is not surprising that there are no known remaining eighteenth-century dwellings directly attributable to mining in the Richmond basin. However, these eighteenth-century mining communities expanded as the industry did, leaving behind indelible marks on the nineteenth-century landscape.

The combination of new canals and turnpikes lacing the Richmond countryside allowed the expansion of the coalfields, with new pits opened in the nineteenth century that had previously been inaccessible because of their distance from transportation. Coal mine owners went to great lengths to have canals arranged so that they were advantageously situated near their coal pits. The Tuckahoe Canal Company in 1828, with Thomas Randolph as one manager, constructed the Tuckahoe canal from the James River canal, west of Tuckahoe Creek, to a point on Tuckahoe Creek near Crouch's Coal Pits. This canal was comprised of both canalized sections of the creek bed, as well as excavated canal sections. In 1829, the Tuckahoe Canal was open to Cottrell's Coal Pits, located near the junction of Deep Run and Tuckahoe creeks (Manarin and Dowdy 1984:196). By 1830, the canals, along with the turnpikes, encouraged an estimated 25 different pits to be in operation. Those pits produced a total output of 66,720 tons in 1825, and 102,799 tons in 1830 (Eavenson 1942:443).

During this period, several families made names for themselves and their heirs in the Richmond coal business. Included among such families were the Cunliffes, Wooldridges, and Heths. The Heth family had begun operations at the Black Heath Mines in 1788. This family exemplifies both the best and worst in the early to mid-nineteenth-century Richmond coalfield.

Harry Heth Jr. had been the first to bring foreign expertise to his Richmond mines. He brought to Chesterfield County two Scottish miners in the first decade of the nineteenth century to work the Black Heath shaft again after it had been closed by fire. The Scottish miners were able to more skillfully work these extensive seams of coal, often 30 to 50 feet thick, and were even able to turn the still-raging coal fire in the old workings to advantage. A passage was excavated to the deserted fire-ridden works and fitted with a door, which could be opened or closed creating a crude method of ventilating the accumulated gases (Grammer 1819:128-129). This system had been utilized in English collieries successfully for a number of years.

By 1818, Heth had three shafts open, located near the edge of a steep hill overlooking a small stream 180 feet away. These shafts varied in depth between 300 and 350 feet. The middle shaft was the deepest, and was worked with the help of a Boulton and Watt steam engine, which pumped out water exclusively. Heth had apparently ordered this steam engine in 1811, probably with the advice of his Scottish miners, making it the first ordered for any coal mine in the United States (Eavenson 1942b:203). The coal corves, loaded at the pit bottom by slaves and free blacks, were raised separately by a mule-powered windlass, or whimgin (Grammer 1819:127).

Heth was also involved in numerous other mining activities in the Richmond basin. He entered into several partnerships with other mine operators, such as John Cunliffe, Thompson Blunt, Nicholas Mills, Andrew Nicholson, and others. In 1819, Heth, along with Cunliffe, Blunt, and Porter, founded the "Coal Mine Seminary." The seminary at Coalfield (Midlothian) was governed strictly by this board of trustees, and operated with a school year of 10 months, comprised of six-hour days. The object was to teach young men the technical aspects of English coal mining and apply them to the Richmond coalfield (Henry Heth Papers; Weaver 1975:41; O'Dell 1983:412). The Seminary was to promote more skillful, and hence, more profitable mining in the Richmond basin. The outcome of the Seminary is unknown.

Perhaps another aspect of the introduction of English coal mining principles were mine logs, or journals, kept by owners and operators. At the Black Heath Mines, as well as his other coal assets, Heth kept account books and notes. While the majority of these notes concern payments due from various community members, there are a few mentions of buildings associated with his pits. Heth's Schedule of Coal Land mentions the "No.1" mine at Black Heath which had "...an overseers house and a few Negro Huts" as the only improvements, and the pits on Falling Creek (Heth owned two-thirds interest in 100 acres) which had "...tolerable improvements for a small family..." (Henry Heth Papers). These structures were probably of frame or log construction and had one or one-and-one-half stories. Thus, company housing was provided at no great cost to the company.

Upon Henry Heth's death in 1822, his will stipulated the division of his coal property, land leases, and especially his slaves. During Heth's thirty years of mining, he had come to own a large number of skilled slaves, as well as leases for services of unskilled slaves from other slave owners. These slaves worked in and around Heth's various coal pits, as well as at his coal yards in Richmond (Henry Heth Papers). He firmly believed in training his own slaves in highly skilled positions, such as mine foreman, within the coal business to ensure stability (Lewis 1987:5; Morrison 1974:11). Thus, Heth's mines ran smoothly with slaves who knew the mines and the mining systems well.

After Heth's death, his son John continued the family business. In 1822, John Heth and Beverely Randolph reorganized the Black Heath Pits into the Black Heath Company of Colliers. In 1832, John Heth, Beverly Heth, and Beverly Randolph petitioned the Virginia legislature for permission to incorporate their Chesterfield properties, for as "proprietors and tenants" they held "in common..several parcels of land...on which are valuable coal mines...and some personal property consisting of slaves, mules, carriages, machinery, other articles of visible property, and a floating capital in money...." All of this stock allowed the Heth's and Randolph to "...carry on the business of colliers" (Chesterfield County Petition 1832). They were allowed to incorporate in 1837, and formed the Black Heath and Huguenot Coal and Iron Company (Brock

1892:320). The previous year, the Black Heath Company of Colliers was sold to the English-owned Chesterfield Coal and Iron Mining Company (***Richmond Enquirer*** March 23, 1836).

During John Heth's lifetime the Black Heath coal pits achieved a good deal of notoriety. The West Point Foundry would use no other coal, and they were not alone in their praise of the Black Heath colliery's coal (Morrison 1974:11). The United States Navy Agents' Office, requested 25,000 bushels of coal from Richmond, "equal in quality to the Black Heath Company of Colliers coal" (***Richmond Enquirer*** March 23, 1837). To continue to serve the public's growing demand for coal, the colliery was expanded, as well as transportation facilities. In 1836, John Heth and Alexander Duval petitioned the Virginia assembly to obtain the right to construct a "new" railroad from the Chesterfield coal pits to the James River. This would alleviate the trip on the Chesterfield and Manchester Railroad to the landings opposite Rocketts, and then into the City of Richmond by wagons and carts. The wagon transportation caused a great "enhancement of price" when the bushels of coal sold in Richmond (Richmond City Legislative Petition 1836).

This petition was also granted, and the James River and Black Heath Railroad was constructed for a distance of 13 miles to the James River. Other coal companies and individuals followed suit and the Duval railroad, one and one half miles in length, ended at the James River a quarter mile above the James River and Black Heath railroad. The Etna Coal Company railroad "communicates" with the coal pits in Powhatan County, and ends 19 miles from Richmond at the James River. Nearby, the Tuckahoe railroad, four and three-quarters of a mile long, extended from the Tuckahoe pits to the north bank of the James River and Kanawha Canal. The Tuckahoe Canal (completed c.1828), five and three-quarters of a mile long, served the Tuckahoe coal pits, connected with Tuckahoe Creek, and after navigating the creek with bateaux laden with coal, they entered the James River and Kanawha Canal near Bosher's Dam (Richmond ***Enquirer*** January 7, 1840).

In 1838, the Black Heath mines, worked now by the Chesterfield Mining Company, experienced an explosion in their newest 700-foot deep shaft. The ***Richmond Enquirer*** (March 23, 1839) lists two foremen and approximately 40 colliers, all African-Americans and primarily slaves owned or leased by the company, as dead. This explosion again led Heth to turn to others more experienced in mining for help.

English mining engineers, Frank Foster and T.Y. Hall, were employed to lay out new workings in the English style, and they brought with them an English foreman to conduct the daily underground operations. Foster and Hall, with advice from the famous John Buddle, English mine viewer and engineer at the collieries at Newcastle-upon-Tyne, managed the mines and their ventilation. They also did the same for the Midlothian Coal mines, under A.S. Wooldridge. According to an advertisement published in the ***Richmond Enquirer*** (January 9, 1840), Foster and Hall testified that their use of the "plan pursued in the North of England" would result in only the normal mining risks, instead of the constant hazards that had previously existed in the Richmond mines.

Heth traveled to England again in 1841 to generate foreign interest for stock in his growing American coal business. He attempted to incorporate coal land from various tracts he had recently purchased, such as the old Salle pits, the Maidenhead pits, and other properties. During the time in England, John Heth became ill, and upon his return to his sister's estate at Norwood in Powhatan County, Virginia, died of consumption (Morrison 1974:13).

John Heth unfortunately did not have a son who wished to enter the coal business when he died. His son Henry long since had lost any fascination with the coal mines around his home. In his youth he had been forbidden to descend into any mine; however, curiosity won out and Henry bribed a foreman, "an old darkey," into taking him into the "mine seven hundred feet deep." He remained in the pit for over two hours, after which "the illusion of a coal pit was dispelled from that day" (Morrison 1974:11).

After serving the Confederacy as an officer, Henry Heth was asked by Gen. Burnside if he would be interested in buying or renting a "piece of coal land, and work it?" Heth decided to make a go of his father's previously lucrative profession, and leased a tract of land on the James River for twenty years, with a royalty paid on the coal mined. Despite Burnside's promise to "honor your drafts...to carry on the work," the enterprise failed (Morrison 1974:202). Henry Heth's failure during the late nineteenth century was typical of the Richmond coalfield; coal prices had dropped due to competition from the Pennsylvania and West Virginia coal mines, and the Richmond mines became too expensive to mine, with the cost of coal scarcely covering the costs of mining. Like many others in the mid-nineteenth-century coal business, Heth went on to other occupations (Morrison 1974:203).

However, before the failure of the Heth family mining operations, as well as the Wooldridges, the operations helped the mining community of Coalfield (Midlothian) become a more settled village with company-built amenities. In 1835, seven or eight major mines in the Midlothian area were producing 75,000 tons of coal annually. The companies operating the mines owned over 300 mules and horses, and employed 700 to 800 men. With their success, the companies were able to dispense $250,000 a year back into the community (O'Dell 1983:84). Within the next two decades, Coalfield became one of the larger settlements in Chesterfield County. The majority of the growth and building done during this antebellum period was due to the Midlothian Coal Mining Company, owned by the Wooldridge family and others (O'Dell 1983:7).

The Company constructed numerous buildings for the benefit of their employees. A Company Hospital (demolished in c1910), a brick structure two stories high, was fitted to minister to the needs of the several hundred company miners. At one time, three or four doctors were in part-time company employ. The company also constructed a brick store (demolished in c1910), that served as a commissary for the miners. A company-owned bakery (demolished in the early twentieth century) was also built to provide bread for miners and their families. This frame structure may have later served as a Union hospital during the Civil War (O'Dell 1983:90).

Housing was also provided by the Midlothian Coal Mining Company, with the construction of a brick rowhouse in the village, near the railroad spurline to the Grove Shaft (demolished). The brick dwelling consisted of one story, with eight to 10 single room units. Each unit had one window, a front door, and was heated by a coal-burning stove. A single mining family occupied each unit. The company also owned additional housing at the Grove Shaft, consisting of 10 two-unit brick dwellings. Most of these buildings were one-and-one-half stories, with dormer windows, and exterior end chimneys. Each unit within a building had a main floor room, with a lean-to kitchen, a loft, and a front veranda (O'Dell 1983:413). Housing was also present near the Railey Hill pits. The frame structure known as "Railey Hill" was constructed as a residence for the mine superintendent. Individual workers housing lined the road leading up to the house (O'Dell 1983:221). These were on brick foundations, and of log or frame construction.

The miners and their families had erected two churches in Midlothian, the Old English Church (demolished) and the African Baptist Church (First Baptist Church of Midlothian). The Old English Church was built by English and Welsh miners of the Methodist denomination in the 1840s, and later abandoned in 1878 when the foundation began to subside from the underground mining. The African Baptist Church was founded by the large slave and free black collier population of Midlothian in 1846 (O'Dell 1983:90).

The new coal pits opened after the 1830s, by families such as Cunliffe, Wooldridge, Blunt, and Heth, as well as companies, required better, faster and cheaper forms of transportation than the turnpikes, mine access roads, and canals could provide. Therefore, the advent of the railroads was very welcome in the Richmond basin. In 1831, the tracks of the Chesterfield and Manchester Railroad were completed, to provide transportation for the Midlothian mines to the James River. Coal was then loaded into barges and taken to Rocketts for sale (Wilkes 1988:9). The Chesterfield and Manchester Railroad would operate in this manner until 1850, when the Richmond and Danville

Railroad (now the Southern Railway System) eliminated the need for the gravity rail line (Wilkes 1988:8).

The Richmond, Fredricksburg, and Potomac Railroad (1834) constructed a branch line in 1837 to the Springfield and Deep Run Coal Pits in Henrico County. The pit owners, DuVal, Burton and Company, and John Barr, advanced the money to construct the line to their pits, and were repaid by interest from the tolls charged (Manarin and Dowdy 1984:223).

The Clover Hill area in Powhatan County had mines opened in 1839 by James Cox (Wilkes 1988:29). Another antebellum mining settlement developed as a result of the Clover Hill mines, called "Clover Hill" (present day Winterpock, Virginia). It originated because of the great success of the Clover Hill mines, which were to become one of the major coal-producing centers on the east coast. At it's peak, between 1850 and 1860, Clover Hill had approximately 1,000 people living there, most of whom were miners and their families. They occupied between 100 and 200 company-built workers' housing units, which were probably similar to the housing forms provided by the Midlothian Coal Mining Company at Coalfield (O'Dell 1983:7,8;213). The village declined rapidly after the Clover Hill mines closed at the end of the nineteenth century. These houses were demolished in the early twentieth century (O'Dell 1983:213).

The Clover Hill mines also required transportation other than the combination of wagon and boat rides to Petersburg. These rough modes of transportation physically damaged the coal, thus lowering its market price. This transportaion was expensive because of the tolls charged on each wagon or boat filled with coal. The construction of the Clover Hill Railroad in 1841, alleviated this problem. The railroad was transporting Clover Hill coal to Chester for sale. Another railroad spurline transported coal from the pits to barge loading facilities at Epps Falls on the Appomattox River (Wilkes 1988:9). The success of this railroad enabled the Clover Hill Mining and Manufacturing Company in 1847 to begin an 18 mile long railroad spur to the Richmond and Petersburg Railroad (1836) at Chester Station (Wilkes 1988:29).

These endeavors sparked a new concept among railroad and coal magnates, that of sharing costs and profits by building spur railroads to the individual mine operations. Between the Chesterfield and Manchester Railroad in 1831 and the early twentieth century, numerous spurs off the main lines were constructed in the Richmond basin, and changed ownership almost as often as the coal mines did. These spurlines, like the spurline to the Grove Shaft, were an attempt to further reduce the cost of transportion and the damage to the coal by moving it only once prior to market sale.

Another concept was the incorporation of mining lands under management of private individuals. This was prompted by the increased availability of Pennsylvania and western Virginia anthracite coal brought to Richmond and Petersburg on the new railroad lines. These railroads were improvements on a nationwide scale; however, they would prove to eventually be the death-knell of the Richmond coalfield. Therefore, in response to this outside threat, the initial reaction of Richmond mine owners was to consolidate by incorporating previously independent operations (Manarin and Dowdy 1984:228).

One of the earliest incorpations was the charter granted to the Black Heath Company of Colliers in 1833. Others followed suit, and in 1835 the large Midlothian

Coal Mining Company was chartered primarily by members of the Wooldridge family. In 1837 the Rosewood Coal Mining Company (Wooldridge family) and the Persons Coal Mining and Iron Manufacturing Company were chartered. In 1837, the Wooldridge family also chartered the Chesterfield Coal Mining Company. Another local mining family, the Cunliffes, chartered the Cold Brook Company of Colliers in 1835. Other companies, such as the Coal Working Company of Richmond and Manchester (1836), and the Creek Company (1837), were also chartered in Chesterfield County (Lutz 1954:191-192).

In Powhatan County, the Ben Lomond Coal Company (1837), Etna Coal Company (operated in both Chesterfield and Powhatan in 1838), Appomattox Coal Mining Company (1837), and the Cox holdings (1840) were incorporated (Lutz 1954:192). Henrico County had incorporations of lands in the Tuckahoe Valley, under the name Runnymeade Coal Mining Company in 1837. In the same year, Thomas Randolph and John Brockenbrough incorporated their coal pits as the Tuckahoe Coal Mining Company (Manarin and Dowdy 1984:228). These companies were all chartered with various amounts of capital available to the company, based on the company share prices.

During 1841, there was an effort in Chesterfield to bring all the coal mines under one ownership and management. The Chesterfield Coal and Iron Mining Company was incorporated, with capital of from $500,000 to $1,000,000. The incorporation included many mines, in addition to the Heth and Wooldridge family properties (Lutz 1954:202).

Prior to the Civil War, the coal mining business had been exclusively Virginian, with Virginia capital invested in it, with the necessary exception of the English capital introduced during the 1840s by John Heth. Large profits were reaped before the war, allowing families like Heth, Wooldridge, Railey, Randolph, and Mills to become some of the wealthiest in Virginia in the mid-nineteenth century. The profits were a result of, for a brief time, cornering the coal market along the east coast (Bruce 1960:104). Great sums of money were invested in the coal industry at it peak. In 1840, an estimated $80,000 was spent on labor and transportation for two million bushels of coal from Chesterfield, Henrico, and Goochland counties. An additional $120,000 was expended for supplies (Bruce 1960:107). This capital came primarily from Virginia and stayed primarily in the Richmond area.

To generate capital from company shares, the mines had to demonstrate their stability and ability to produce profits. The incorporations were indicative of the increasing recognition among mine operators in the Richmond basin that to be run profitably, they must be managed well. Mining engineers from England gave advice on mine layouts; English, Welsh, Cornish, and Scottish colliers worked as overseers and experienced hands alongside free blacks and slaves in the mines.

Similar activities were taking place in Chesterfield, Powhatan, and Goochland counties. When Henry Howe visited the Midlothian coal mines in 1843 he was greatly impressed. Howe commented that the 150 "negro workers" in the mine he visited were well fed and clothed, as were the company mules stabled underground. The blacks told Howe they preferred this work to the fields (Howe 1843). By 1846, there were approximately 200 hands, "Americans, English, Scotch, free blacks, and slaves," managed by an English mine superintendent (Richmond ***Whig and Public Advertiser*** June 26, 1846).

The English colliers and engineers who immigrated into the Richmond area, brought with them current working techniques designed to obtain the most coal with the least expenditure in effort and safety. However, the very irregular nature of the Richmond basin would not allow the regular square pillar system (pillar and stall, pillar and bord) to be used at all mines, especially the Midlothian mines. The Staffordshire system was also attempted, but the pillars could not endure the weight of the overlying strata. These failed systems allowed gases to accumulate around corners and in areas closed by rubble or collapsed sections. Even the advanced ventilation systems could not clear the workings of the gases (Routon 1949:60).

The English engineers did make the Richmond mine operators aware of the definite advantages of steam engines, both to hoist and to pump. The peculiarities of the Richmond basin did not preclude their use. At a few collieries, steam engines were installed, both at pit head and bottom. However, the powerful steam-powered engines were expensive purchases, and were made accessible to most mining operations only after incorporation capital was available.

Nevertheless, the efforts of the English engineers and Richmond mine operators were not enough to prolong the industry's life. The ***Richmond Compiler*** noted on September 28, 1846, that the anthracite coal trade had already superseded the Richmond bituminous trade along the coast. The explosions in Richmond mines also further dampened enthusiasm for the Virginia mines, both for potential shareholders and slave owners looking for extra employment for their property.

Mining Techniques: 1794-1850

Coal mining techniques gradually improved in the Richmond basin when skilled English engineers and Welsh and Cornish miners immigrated at the beginning of the nineteenth century. These engineers and colliers brought with them the experiences gained throughout several hundred years of bituminous coal mining in England.

By the beginning of the nineteenth century, the vast majority of coal mining in the Richmond basin was conducted almost completely underground, although there would always be the smaller-scale operations for domestic use. The deeper shafts were lined with timber, stone, and sometimes brick to prevent water leaking and landslides. However, the great depth of the shafts at the larger operations caused several serious problems to present themselves -- namely the intrusion of water into the workings and gas accumulations, which resulted in explosions.

The intrusion of water was more easily handled than the gas. As the shafts excavated to greater depths filled with water, and it had to be ceaselessly removed from the workings. At the Midlothian mines, even Sundays were spent removing the accumulated water (Wooldridge 1841:343). Animal-powered windlasses hoisted water in buckets from a sump at the base of the workings. Mules on the surface of the mine turned round in a circle, powering the windlasses (Wilkes 1988:9). This practice would continue virtually until the late nineteenth century at the smaller operations.

After 1811, steam engines of various horsepowers gradually replaced the windlasses. These steam engines could be used for hoisting water and coal, and the later introduction of water pumps took over the dewatering sometime after the 1880s. As these were all considered large investments, wooden structures were probably constructed to house them, as the English collieries did. Foundations of brick, and sometimes stone, were laid for these engines. Often these were substantial foundations, for in 1863 Christopher Q. Tompkins spent $2,163 laying a foundation at Trents Pits (Tompkins Family Papers: Commonplace Book). However, most smaller mine operations could not afford these expensive pieces of machinery. Typically, steam engines were found at the larger operations such as the Black Heath Company of Colliers, Midlothian Coal Company, and Dover mines.

Steam engines also replaced mules at some mines during the same period. Mines with steam boilers at their base were used to wind cables attached to the coal carts. It also powered a lift to hoist the coal to the ground surface. Blacksmiths employed by the mine were located by the convenient heat source of the boiler within the mine (Wilkes 1988:10). This practice was abandoned after an 1842 letter from the esteemed John Buddle, at Newcastle-upon-Tyne, England to the president of the Midlothian colliery, A.S. Wooldridge. Buddle stated that he had had numerous English collieries set on fire because of boilers situated in the mines. Indeed, a Midlothian colliery mine caught on fire in 1842, because of it's underground boiler (Eavenson 1942:102-104).

Ventilation also was a problem in the deeper underground mines. Fresh air was needed to work the coal face and disperse dangerous gas build ups. Without ventilation, methane gas, as well as coal dust, could be ignited by the mining lamps open flames. Wooden trap doors, and brattice, were installed throughout the mine gangways on various levels to ventilate sections being worked. By combinations of open and closed doors, air was directed to the working face. The English introduced this system in the mid-nineteenth century, although Henry Heth had attempted to use the principle in the Black Heath mines when they were on fire, without success, The ventilation was improved later in the nineteenth century by the excavation of two shafts at each mine site. Sometimes, older shafts or slopes were utilized as ventilation shafts to reduce costs. However, these were much more dangerous because of the possibility of old accumulations of gas being ignited, or flooding from the old works. Nevertheless, one of the parallel shafts, whether old or new, acted as a downcast shaft bringing in fresh air, while the other upcast shaft removed stale, gaseous air. The trap door throughout the mines controlled air flow. Wooden walls, called brattice, were built in the gangways to control the direction of ventilation. By the late nineteenth century, steam boilers were placed at the base of the mine to generate an even stronger updraft. However, the methane gas pulled past the boilers could cause destructive explosions. The boilers were largely replaced by huge fans working with both stone and wooden brattice to control ventilation by the end of the nineteenth century (Wilkes 1988:10).

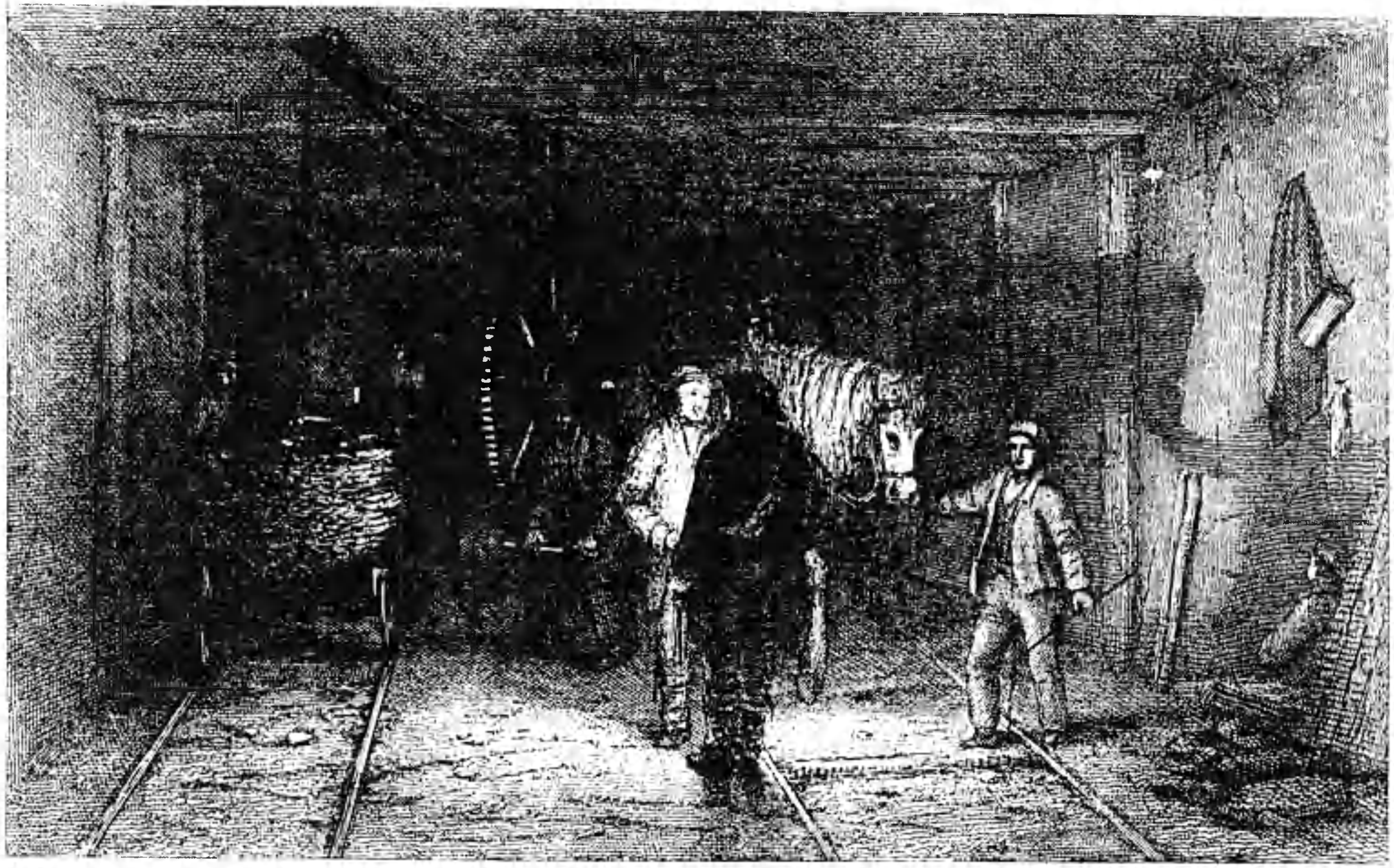
Colliers could clear the mines of gases by using more dangerous methods, such as a "firing line." This was a candle attached to a cord and pulled into a gassy area, igniting the build up. A second method involved the "cannoneer" of the mine. The cannoneer wrapped himself in a heavy, wet cloak and upon entering the gassy area, would lie down on the floor. He then raised a lit torch above his head to ignite the gas (Wilkes 1988:9-10). These methods were relatively safe as long as the gas quantity had not been under estimated. Igniting a large pocket of methane gas would cause a tremendous explosion within the mine workings.

There were numerous pieces of equipment and machinery necessary for a colliery to operate. The quantity and quality at each mine site depended on the size and capital available from the company. Large companies, such as the Midlothian Coal Mining Company in 1838, had on hand "flat ropes, tools, and fixtures; also the Buildings, railroads, Bogies, Cranes, Corves, Slate car, etc..." (Richmond Enquirer Feb.1, 1838; Figure 12). This is in addition to their steam engines, and spare parts. Other slightly less affluent operations advertised "drawing machinery," which probably indicates whimgins or windlasses (Ruffin 1837:315-318). The Creek Company pits in 1841, owned "all necessary machinery, mules, and about 30 men, with a sufficient outfit of houses, two coking ovens, and a branch railroad" (Wooldridge 1841).

That is the first mention of man-made coke in the Richmond basin. The coking ovens were brick eight feet square, with an exhaust hole on top, and a hinged steel door on the front. After loading in the small coal, it was fired and baked slowly (carbonization). The coke was then raked out and quenched with water. The only other two instances of man-made coke were the Richmond Coal Mining and Manufacturing Company ovens at Gayton Shaft in the late 1800s and possibly at the Clover Hill Pits between 1865 and 1870 (Wilkes 1988:10; Tuomey 1842:449-450).

The Dover Mines and Manakin Iron Works (c1845 to c1855) had neatly divided their industrial complex, located south of the Kanawha canal, and their coal mining and domestic/living area, located north of the canal (Figures 13 and 14). In their Dover mines

Figure 12



Crane for loading the rollies (After Hair 1844).

report (1850), engineers Smithurst and Vivian, noted a "considerable number of houses on the property, a store, blacksmiths shop, steam engine of some 40 horsepower, mules, wagons,..." (Tompkins Family Papers).

Richmond Coal Mining History: 1850-1939

By 1850, the railroad lines had opened up the southwestern portion of Virginia, as well as western Maryland and Pennsylvania, which contained better quality anthracite coal. The availability of the new anthracite coal had a telling effect on the Richmond mines, especially when it was combined with the increasing number of explosions in the Richmond coalfield. Consumers associated dangerous mines with poor quality coal, and therefore began to purchase the less smokey, hotter-burning anthracite. By 1860, the only mining of consequence in Richmond was at the Midlothian and Clover Hill properties (Eavenson 1942:129).

During the Civil War, Richmond coal mining efforts were directed toward supplying the Confederacy. The Confederate States of America were concerned enough with coal supplies that they opened and operated their own slope mine in Chesterfield County, known as the "Bingley Slope," for the duration of the war (Shaler and Woodworth 1899; Figure 15). There was some competition from coal mines in North Carolina, Tennessee, and Alabama (Eavenson 1942:129); however, the railroads that interlaced the countryside could not readily transport this coal to the Richmond foundries. When the railroad gauge changed, the coal would have had to have been moved, which

Figure 13

1860 Map of the Dover Mines. Arrow indicates the location of the Manakin Iron Works south of the James River and Kanawha Canal (Virginia Historical Society).

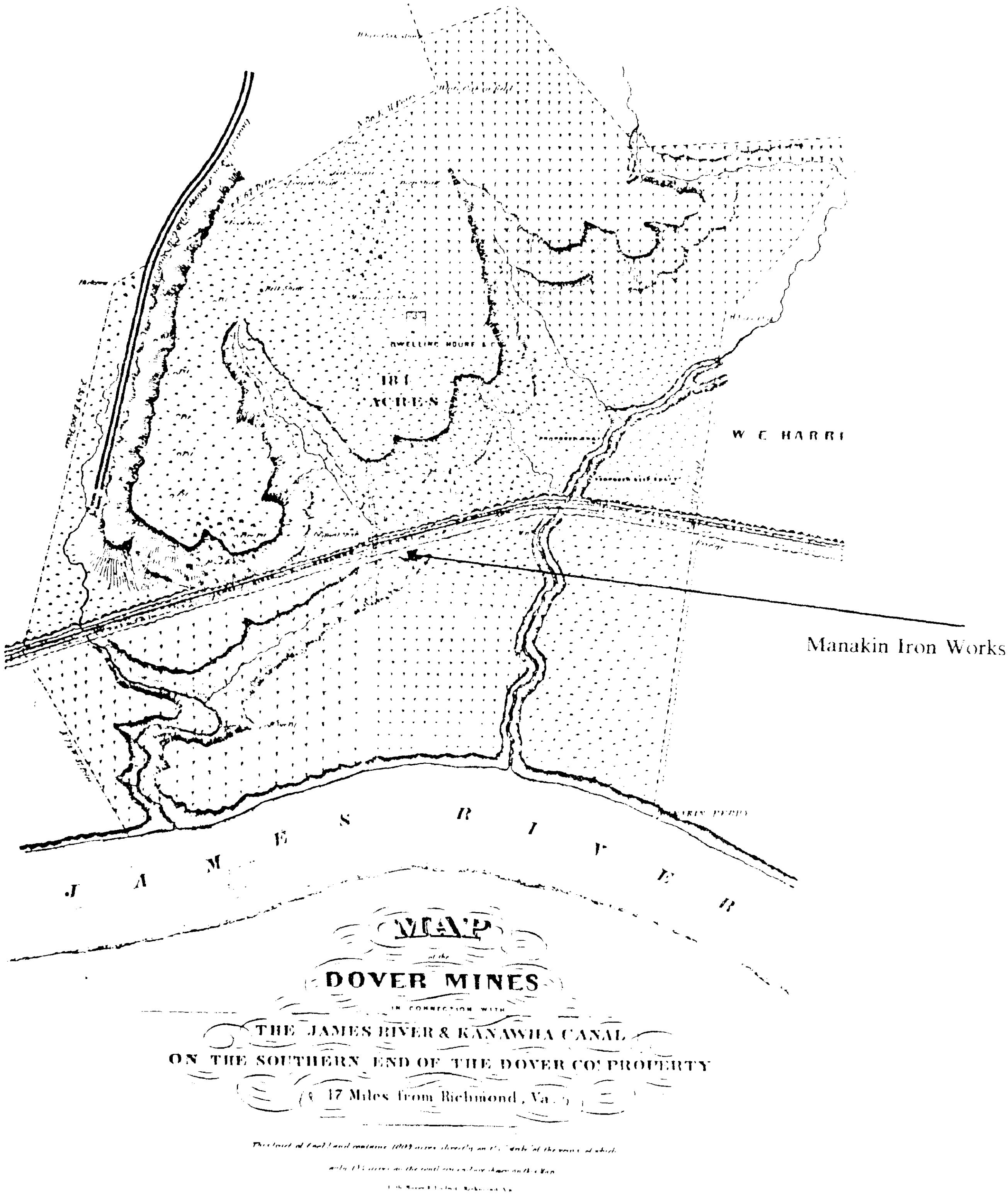
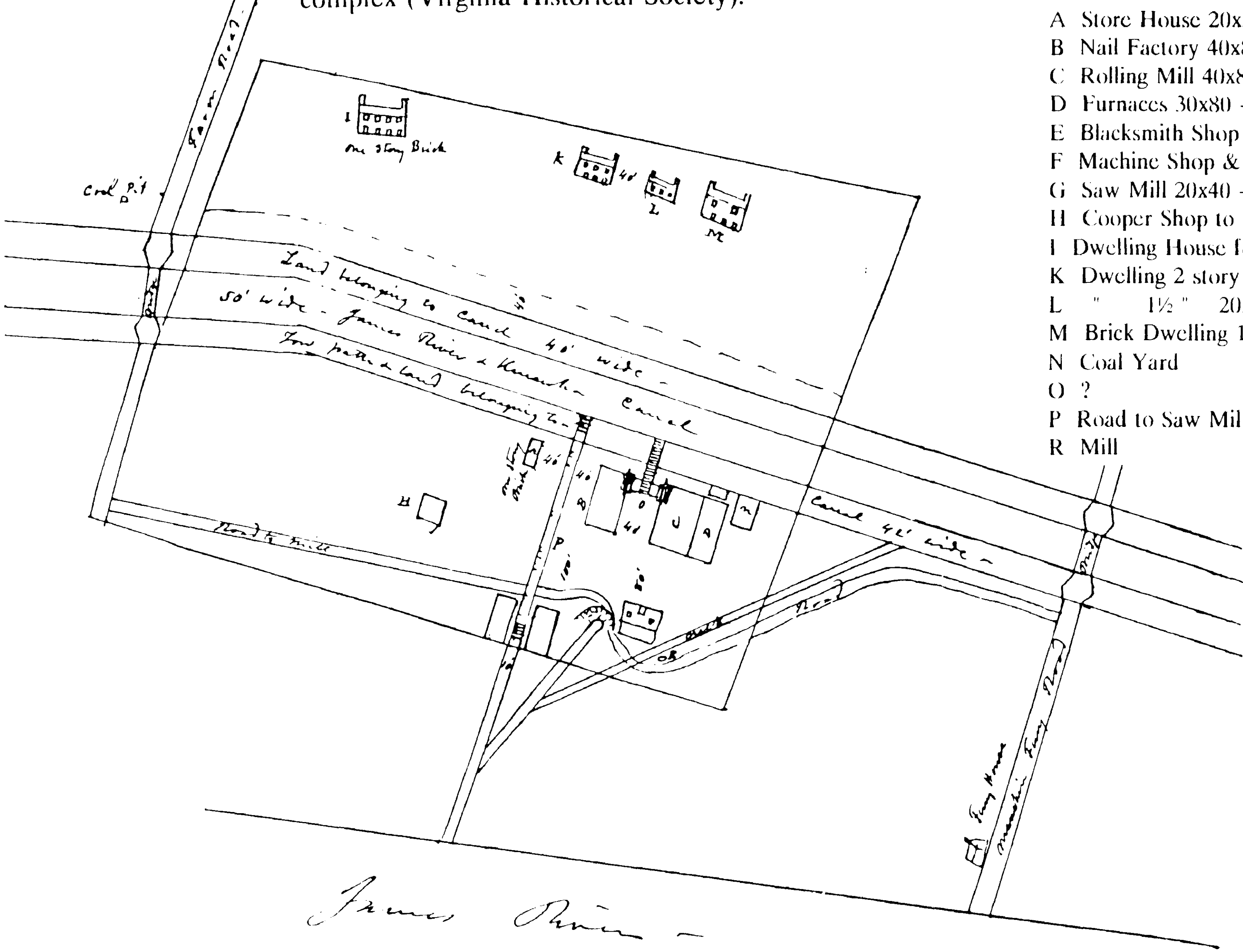


Figure 14

Plan of the Manakin Iron Works (c1845-1855). The industrial complex is located south of the James River and Kanawha Canal, with the domestic complex directly to the north. The southern end of the Dover Coal Mines is visible immediately to the west of the domestic complex (Virginia Historical Society).

A Store House 20x30 - 80' from the Nail Factory
B Nail Factory 40x80 - 40' " the Rolling Mill
C Rolling Mill 40x80 - Shelter
D Furnaces 30x80 - Shelter
E Blacksmith Shop 20x30 - 80' from Mill
F Machine Shop & Grist Mill 40x20
G Saw Mill 20x40 - 100' to house
H Cooper Shop to itself
I Dwelling House for boarders to itself
K Dwelling 2 story 20x40 - 40' apart
L " 1½ " 20x40
M Brick Dwelling 1½ story 20x40
N Coal Yard
O ?
P Road to Saw Mill
R Mill



would have raised the transportation cost, in addition to physically damaging the coal in the process (Dr. Stephen Potter, personal communication 1991).

Thus, the price and demand for Richmond coal rose, and many mine owners attempted to expand their operations. However, the size, depth, and inability to adequately ventilate the shafts, caused many failures (Jones n.d:76). The interstate transport of this coal was also hampered by the fighting. As a result, the Tredegar Iron Works, which produced the bulk of early Civil War munitions, was supplied with coal from nearby mines. This allowed Tredegar to play "a significant part in that collection of forces which made Virginia in 1861, industrially superior and requisite to the other Confederate states" (Bruce 1960:108-109).

Tredegar Iron Works also worked to ensure they received the necessary coal by purchasing the Dover Coal Mining Company, along with the Midlothian Coal Mining Company, and the Clover Hill Coal Mining Company, and consolidated them into one firm under the general management of Christopher Quarles Tompkins, then a colonel in the Confederate Army (Bruce 1960:88; Tompkins Commonplace Book). In 1863, the new firm employed over 291 black miners, most of which were hired annually ("List of White Persons at Dover Pits 1864;" "List of White Hands at Trent's Pits 1865" Tompkins Commonplace Book).

In 1864, 250 colliers, mostly slaves, worked at the Dover mines and the Tuckahoe mines. The efforts of the Dover mines to supply the Confederacy, are chronicled in Tompkin's Commonplace Book, 1863-1867 (Virginia State Historical Society). Between 1863 and 1867, Christopher Tompkins wrote of "Negroes at Dover Farm and Pits." He

Figure 15

U. S. GEOLOGICAL SURVEY NINETEENTH ANNUAL REPORT PART II PL. LI

Method of working a slope mine at a shallow depth by use of a mule gin, Bingley Slope, 44CF319 (After Shaler and Woodworth 1899).

listed as stock at the Dover Coal Pits on June 1, 1863, such items as "...7 brick houses, 4 small wooden houses, 3 large wooden houses" as sell as the industrial structures from the Manakin Iron Works complex (located to the south), such as "1 grist mill and 1 sawmill" (Tompkins Family Papers: Commonplace Book; see Figures 13 and 14). Tompkins also listed his expenditures on food and equipment, as well as his "negroes" and their jobs and rates of payment to their masters. However, in 1865 these slaves were conscripted during the Confederacy's last efforts (Manarin and Dowdy 1984:234).

The end of the Civil War underscored the evident decline of the once prosperous Richmond coalfield. Several changes took place directly after the war that had significant impact on the character of Richmond coal mining. After the Civil War one such change was apparent in the work force at the mines. English, Welsh, and Cornish immigrants, desperate for work, joined the freed blacks in the mines (Wilson and Slay 1981:93). However, there seemed to be a marked preference for freed blacks over whites. As the blacks were the most familiar with the conditions in the mines, this is not surprising. According to Oswald Heinrich, as late a 1871, most of the labor force working for the Midlothian Mining Company, and probably other companies, was black, "...although we have a few good white miners amongst us" (Heinrich 1871:356). It is unknown if housing was provided for these hands as it had been in the previous periods. The former slave "huts" and wooden houses probably continued to house the post-Civil War workers.

After the Civil War, there were attempts to recapture the prosperity of the pre-war period. The war had destroyed many railroad lines, some of which provided service to the mines. One of the first tasks of the Reconstruction was repairing these, as well as building new lines. New coal companies were chartered, such as the Chesterfield Gas Coal Mining Company in 1865, and the Tomahawk Coal Mining Company in 1866 (Lutz 1954:269). Some of the more successful endeavors were the Carbon Hill Coal Company, chartered in 1866, and the James River Coal Company, chartered in 1874 (Manarin and Dowdy 1984:345).

During ensuing years, more mining was conducted by "outsiders." These efforts were focused on reopening the old shafts, which were reported to still contain a high volume of coal due to what the outsiders saw as the "incompetency, folly, gambling, drunkeness, cruelty, laziness, and short-sighted avarice" under which the pre-war mines had operated (Anonymous 1883:171).

Unfortunately these new efforts were still hampered by the Richmond coalfield's bad reputation for explosions, which apparently rendered the coal itself suspect in purchasers eyes. Although the mines had been operated with much safer methods since receiving English advice, the mines continued to have explosions and accidents. The Bright Hope coal pits had an explosion in 1867 that killed 30 white and 39 black colliers. In 1875, an explosion at the Raccoon Slope killed three, and another explosion the following year at the Grove Shaft killed eight colliers. The Grove Shaft experienced several explosions, including one in 1882 that left 32 dead (Humphrey 1959). This blast led to the General Assembly naming a committee to investigate and make recommendations for better management of safety in the mines (Lutz 1954:289).

During the 1870s, there had been renewed efforts to mine with more modern, safe means. As the geologic nature of the Richmond basin was better understood by men such as Oswald Heinrich, an English geologic and mining engineer, it was deemed possible to make extracting the coal profitable. A few years later, Martin Coryell, mining engineer, expressed identical beliefs that the Richmond coal mines could be successfully mined with "scientific knowledge, mine surveying, and careful recording of notes" (Coryell 1874:288-289).

Drilling was one such new "scientific" technique. Drilling had been used by English collieries, and was introduced into the Richmond coalfield in the late 1860s or early 1870s. The process of drilling enabled mine owners and managers to locate coal seams and ascertain thickness, as well as any potential safety problems before sinking a new shaft. Percussion drill, the first type used in Richmond, could be effective to depths of 500 feet. The rotary diamond drill was used by O.J. Heinrich on the Midlothian Coal Mining Company property in 1874. This core hole reached a depth of 1,142 feet (Wilkes 1988:10). These newer techniques seem to have come a little too late for the failing Richmond coalfield to have taken advantage of the information provided by coring. The drilling was also expensive, with Heinrich's core hole costing $3,548 for 240 hours of labor, and therefore, most exploration was still done by the excavation of shallow pits (Wilkes 1988:10).

During this period of mining there were several Richmond collieries in operation, producing limited amounts. These included Clover Hill, and Midlothian operations, the James River Coal Mining Company's (1874) operations at the Carbon Hill Coal Company's property (1866), the Old Dominion Coal Company operations, and those mines owned by individuals such as Wilkinson and Duval. There were other smaller pits being worked scattered throughout the basin (Coryell 1874:288-289).

In 1880, there were in operation the Bright Hope (old Clover Hill property), the Cunliffe, the Union, and Midlothian mines (reopened from older works) (Mining Directory Vol.15). The Grove Shaft had been reopened briefly in 1882, after a severe explosion had forced its abandonment (Anonymous 1882). However, in 1885, the Bright Hope mine was the only mine operating in the Richmond basin (U.S Geological Survey 1887:35).

The Bright Hope mine was reported to be worked out by 1889, when the Farmville and Powhatan Railway purchased the Clover Hill property (Eavenson 1942). The Carbon Hill mines continued to be worked by the Richmond Coal Mining Manufacturing Company (1882). Later, the mining community of Gayton, named after the Gayton Shaft, was situated around the Carbon Hill shafts during the 1890s. This mining community was comprised of a group of approximately 40 houses, at least some of which were constructed by the Richmond Coal Mining and Manufacturing Company. After the Richmond Company purchased the mines, new ventilation equipment was installed to improve the internal conditions of the mine (D'Invilliers 1938:29).

By the first decade of the twentieth century, there was a sufficient quantity of coal and natural coke in the Carbon Hill mine area to warrant the investment of additional money. Over $20,000 was allocated toward the construction of miners housing adjacent to the mine. A new ventilation system of fans was installed, and three 120 horsepower and two 200 horsepower boilers, a three-story breaker building to break up large coal, boiler and engine buildings, machines shope, and storage bins were constructed for processing and storing the coal. Company stores and stables were also built (D'Invilliers 1938:29). This operation continued until 1912, when an explosion in the old Gayton mine ended mining at this site. This was the last in a series of explosions and accidents that had finally become unacceptable (D'Invilliers 1938:43).

The Midlothian Coal Company's property, which had been idle until 1894, was eventually purchased by Pennsylvania mine operators. After insisting their vastly superior knowledge would allow them success, they had spent all their capital by 1895 attempting to locate coal east of the Grove Shaft, as well as reopening the shaft. The property was idle until 1902, when the Richmond syndicate purchased the property, and installed a modern double track slope and pumped out the shaft. This syndicate also failed to make any profit (Jones n.d:78).

In 1920, the Murphy Coal Company purchased the property. This company also improved the tract by installing two modern 250 horsepower boilers for hoisting and pumping, high power pumps, a double tracked incline, a tipple 200 feet long (coal washing and sorting building), one large storage bin, engine and collier houses, and an office building. These were located 200 yards south of the Grove Shaft. By 1923, this company was producing approximately 50,000 tons of coal. However, by 1925 mining had ceased (Roberts 1928:95-116).

During the period between 1925 and the 1930s, the only mining in the Richmond basin was done for domestic fuel, such as at the Rudd mine in the Clover Hill district (Roberts 1928). The attempts in the 1930s were primarily from outside interests, who were chartered under the names of John R. McLean Coal Mining Corporation (1937), and the Great Southern Morgan Coal and Coke Mining Corporation (1937). They leased several thousand acres in Chesterfield and Powhatan counties and explored opportunities to reclaim the Richmond basin mines (Richmond ***Times-Dispatch*** July 26, 1937; Dec.25, 1937). In 1938, the National Industrial Engineers, Inc. began strip mining the old Bingley tract (which contained the Civil War period Bingley Slope mine). They had two fifty-foot draglines and a crane operating later that same year. Another firm was organized in 1938, and called itself the B & H Coal Company. This company worked the old Southern Coal and Iron Company property, situated a mile north of Robious. They planned to strip mine the section scattered with old pits and shafts, and then drain the water-filled Black Heath mine and begin work there (Richmond ***Times-Dispatch*** Oct. 26, 1938).

These companies could have capitalized on the 1939 United Mine Workers strike; however, the Richmond companies promises to fill orders were empty (Richmond ***Times-Dispatch*** April 21,1939). As a result these last efforts also failed. There have been subsequent drill holes bored throughout the Richmond basin by various companies looking for coal, coke, oil, and gas, but no additional mining activities have resulted (see Wilkes 1988:Appendix II).

Mining Techniques: 1850-1939

During this final period of mining more effort was spent on the apperance of coal. Various stages and degrees of sorting and cleaning were done on the surface. Waste rock, such as shale and slate, were picked out and coal lumps sized by surface workers. Over time, this waste material separated from the coal created a large spoil, or "tailings" pile. The remaining coal could be sorted into a variety of sizes, depending on the purchaser, which determined prices and the type of work they were suitable for such as steam generation, heating, iron working, and other purposes. The coal was not usually washed, as it often was in England (Wilkes 1988:10). The saleable coal was then loaded into coal wagons, canal boats, or railroad cars, depending on the mine site's location and the time period.

Modern mining equipment such as the ventilation fans, powerful water pumps, and large, expensive 250 horsepower boilers were installed at the Carbon Hill mines and at the Grove Shaft during the early 1900s (Wilkes 1988:28). However, not even modern technology could overcome the killing effects of explosions, dwindling coal resources, and ultimately the availability of cheaper, better coal from Pennsylvania, West Virginia, and the southwestern Virginia fields.

Summary

Within several years of the 1701 reference to coal in Virginia, the economic potential of the mineral was recognized. During the first period of Richmond coalfield mining, 1701 to 1794, efforts began as localized removal of coal at outcroppings for domestic use and small-scale iron working. The headwaters of Falling Creek and the Manakin area were reportedly the first areas actively mined. Coal was excavated from shallow bell-pits and trenches cut into the outcropping coal seams.

During the American Revolution, these small-scale mining operations expanded to supply the Westham Foundry's fuel needs for the creation of munitions. The shallow pits were extended downward into shafts, from which gangways extended outward to follow the coal seams. Pithead winding gear, such as windlasses and horse gins, were erected over the shafts to hoist coal, water, and men. Older slope workings nearby were sometimes used as escapeways, ventilation, and haulage tunnels for the newer shaft mines.

The work force at the Richmond mines was provided by the slavery system firmly entrenched in the antebellum South. Slaves from nearby plantations and farms were "leased" by mine operators, or purchased outright to work in the mines. Shelter, typically one-and-one-half story log or frame houses or barracks-style buildings were provided for the slaves, as well as food and clothing. The increasing number of slaves available to work in the pits helped raise the total output of the Richmond mines by the end of this period.

Despite the increasing consumer demand during this period, technological improvements lagged behind. Hoisting capabilities and transportation routes were inadequate for the task. However, the 1794 tariff allowed greater investments of money into mining, and this capital helped build canals, turnpikes, and purchase more powerful mining equipment and English expertise.

During the second period of mining, from 1794 to 1850, the Richmond coalfield reached its peak. The eastern seaboard had first become aware of, and dependent upon the Richmond coal as a result of the Revolutionary War. Later the native coal continued to be purchased, in part, due to the 1794 tariff on foreign coal. By the beginning of the 1800s, coal mines had been opened successfully both north and south of the James River in Chesterfield, Henrico, Goochland, and Powhatan counties. The embargo act of December 1807 and the War of 1812 provided even more stimulus for growth in the coal industry.

Improved transportation during this period also facilitated the expansion of the industry. Turnpikes, canals, and later railroads provided better access to the mines that the previous roads had. Turnpikes, canals, and railroads built during this period opened up the Richmond coalfield, and made previously inaccessible areas economically feasible to mine. However, these transportation improvements and technological advances were expensive, and in response to this, there was a trend toward partnerships and eventually incorporations in the Richmond coalfield. The incorporations allowed company stock to be sold to generate the necessary capital to buy steam engines and other mining equipment, as well as mining-related structures.

The availibility of steam engines greatly affected mining during this period. Steam power allowed deeper mining than the horse gins and windlasses. Steam engines were housed in wood, brick, or stone structures (or some combination of these materials), with brick or stone foundations to keep these expensive pieces of machinery from the elements. Steam boilers also aided ventilation during this period. Boilers were placed either at the pit bottom or on the surface of an air shaft, to help create a natural air current. The air shafts were probably constructed of the same material as the engine housing.

These technological improvements in turn allowed a steady increase in production at the mines. Larger numbers of slaves were purchased or leased to work during this time, with over 500 slaves employed at large mines such as the Dover Pits and Midlothian Mines. As the number of workers increased, so too did their need for housing. Slaves and white overseers settled in company provided housing in communities such as Coalfield and Clover Hill. The establishment of mining communities, with their company-built stores, churches, and other ancillary structures, signaled the more permanent, stable nature of mining which occurred in Richmond during this time period.

Other technological improvements at the mine sites were the result of the early nineteenth-century introduction of English mining principles and equipment. The English, Welsh, and Cornish engineers and managers instituted the "plan pursued in the North of England" to lessen the hazards of mining in the gaseous Richmond coalfield. This influx of English mining technology apparently made investors more comfortable purchasing mining company stock because great sums of money were put into the coalfield prior to it's peak in 1850.

Nevertheless, the combined efforts of the English engineers and Richmond mine operators, the technological advances at mine sites, and the transportation improvements across the countryside could not sustain the industry in the face of the burgeoning anthracite coal trade. In fact, transportation improvements, namely the railroad, caused both the boom and the eventual bust of the Richmond coalfield when the railroad arrived in the anthracite fields of West Virginia, southwestern Virginia, and western Maryland in the 1830s.

In the final period of mining, 1850 to 1939, consumers came to distrust the gaseous mines, and therefore their coal was also suspect. The anthracite mines had no where near the number of explosions, and seemed safer, and therefore the coal must be inherently superior. Technological advances in iron working also allowed the use of anthracite coal. By 1860, the only mining of consequence was in the Midlothian and Clover Hill properties.

The Civil War gave a relatively brief reprieve to the dying industry. The Tredegar Iron Works, who supplied Virginia and the Confederacy with armaments, depended upon a steady supply of Richmond coal, and purchased some local mines to ensure the supply. Due to the different gauge railroads, it would have been difficult for coal from other states to have reached the Virginia foundries. The Confederacy was greatly augmented by this Virginia resource.

However, at the end of the Civil War, the entire face of the coal industry changed. The ready source of slave labor was gone, and retaining a skilled work force became a problem. The transportation network in use prior to the war had been destroyed, and required capital to be rebuilt. Both of these Reconstruction Era problems involved capital, or rather a lack of it. New companies were chartered to generate the necessary capital, and railroads were rebuilt to service the coal mines.

However, at this point technological advances in the actual mining of coal were failing to keep up with the geological problems in the Richmond coalfield. Technological innovations in steam engines, water pumps, fans, and other equipment had allowed mining to reach great depths; however, at these great depths other technical problems were encountered that machinery of the period could not adequately deal with. Finally, the number of accidents in the mines became socially unacceptable, and the majority of the mines closed permanently in 1925. A few mining attempts were made after this, with the final attempt ending in 1939, but the available technology combined with the booming anthracite coal trade had completely displaced the market for bituminous coal. The frontier of the coal industry had passed by the Richmond coalfield.

CHAPTER V

PREDICTIVE MODEL FOR THE RICHMOND COALFIELD

The work in the preceding three chapters has set the stage for a comparison of the English and Richmond coalfields to determine whether or not the two areas were similar enough to warrant the micro-level use of English collieries to provide a blueprint or predictive model for the Richmond coalfield. The predictive model would explain features found in an archeological context within the Richmond coalfield, and also predict and explain potential archeological mining features uncovered during future research.

A historical comparison of the English and Richmond coalfields is best illustrated in table form (Tables 1, 2, and 3). Comparisons between the two coalfields are offset temporally by approximately one century during the first and second mining periods, which is the result of the much earlier beginnings of the coal industry in England. In each coalfield, the development of mining components was detailed. These mining components include: 1) types of excavations used to extract coal and their visible expression on the ground surface, 2) types of mining equipment utilized and buildings (industrial and non-industrial) erected at the mine site, 3) types of transportation, and 4) any attendant manufacturing facilities situated in a symbiotic relationship with a mine.

TABLE 1

Comparison of English Mining Components 13-17th Centuries
and Richmond Mining Components 1701-1794

Time Period	English Mining Components	Time Period	Richmond Mining Components
13-17th Centuries	Mining techniques: surface collection at outcrops; shallow bell-pits; trenches; bell-pits extended into vertical shafts with gangways. Primarily extracted for domestic use, with small use by certain trades. Equipment: ladders; Jack rollers (windlass); cog-and-rung gin, horse gin Buildings: none Transportation: extensive use of natural waterways by larger collieries for London and foreign sea-sale market; small collieries dependent on roads with high tolls for land-sale market. Attendent Manufacturing Facilities: none	1701-1794	Mining techniques: surface collection at outcrops; shallow bell-pits; trenches; bell-pits extended into vertical shafts with gangways. Domestic and small-scale industrial use. Equipment: ladders; windlasses; horse (mule) gin Buildings: quarters for slaves and overseers Transportation: extensive use of road system, with a limited use of natural waterways, to reach Richmond market. Attendent Manufacturing Facilities: none

In Table 1, it is evident that early coal mining in both England and Richmond was basically a necessary fuel-gathering activity and that as little energy and money was invested in the task as possible. In England and Richmond the mining techniques and equipment components would be virtually identical based upon the predictive model. The building component differs between the two countries, as the Richmond coal industry was comprised mainly of a slave work force which required housing and overseer supervision. The transportation component also differs, both inside and outside the mine sites, but this is more a result of the different geographical settings than any social, economic, or technological factor. There were no attendant manufacturing facilities during this time period in either England or Richmond. The scarcity of timber and the advent of the Industrial Revolution in England, and the effects of the American Revolution (and it's subsequent associated tariffs) in Richmond were the impetus for social, economic, and technological changes in each country's coal mining industry during the next time period.

In Table 2, the comparison between the eighteenth-century English coal industry and the 1794 to 1850 period of coal mining in Richmond is presented. The mining techniques, equipment, buildings, and transportation components are all basically identical. However, this period in Richmond contained two attempts at short-term attendant manufacturing facilities, while this phenomena came later in the English coal industry. That difference is a possible result of the more rapid acceptance of the Industrial Revolution in Richmond, and the United States in general. Had the attendant manufacturing facilities relationships in Richmond been successful, they may have prolonged the life of the coalfield, much as the same industrial symbiotic relationships

TABLE 2

Comparison of English Mining Components 18th Century
and Richmond Mining Components 1794-1850

Time Period	English Mining Components	Time Period	Richmond Mining Components
18th Century	Mining techniques: surface collection at outcrops; shallow bell-pits for local domestic use; shafts extended to greater depths by early pumping engines and steam engines. At this point mining became more sedentary as moving became costly. Colliers jobs become more specialized. Equipment: pumping engines; steam engines; horse gins; wheeled corves for iron-shod tramways. Buildings: engine housing of brick or stone; engine foundations of brick or stone; air shafts of brick or stone; miners' housing (rowhouses, barracks); company stores, churches, machine shops, blacksmith, carpenter shops, enclosed shelters of wood. Transportation: navigable waterways, canals, some road use, wagonways (tramways). Attendent Manufacturing Facilities: none	1794-1850	Mining techniques: surface collection at outcrops; shallow bell-pits for domestic use and geological info.; shafts extended to greater depths by pumping and steam engines. English engineers and managers arrive to help impliment the English plan of mining. Equipment: pumping engines; steam engines; horse (mule) gins; coal cars on wooden tramways. Buildings: engine housing of wood, brick, or stone; engine foundations of brick or stone; miner's housing (rowhouses, barracks, 2 family units); company churches, stores, bakery, etc.; machine shops, carpenter, blacksmith shops. Transportation: turnpikes; private access roads; tramways; railroads. Attendent Manufacturing Facilities: Manakin Iron Works and Dover Coal Pits; Major Clarke's Pits and Bellona Arsenal/ Foundry.

did in England in the nineteenth century.

Table 3 represents the final phase of mining in both countries, the nineteenth and early twentieth centuries in England and the period 1850-1939 in Richmond. The mining techniques component is still analogous; however, the equipment component differs. The English coal industry put greater effort into preparing the coal for sale by washing, crushing, and sorting it, whereas the Richmond mine companies roughly sorted the waste rock and did not wash or otherwise prepare the coal. Coking facilities were numerous in England, but unnecessary in Richmond (because of natural coke seams) where only three collieries made limited use of coking ovens. The buildings and transportation components of this period again demonstrate a similar development. However, the attendant manufacturing facilities became very important in England, with numerous ironworks and collieries founding successful symbiotic relationships during this period. The same type of relationship is seen in the Richmond coalfield, but was short-lived.

The final analysis of this comparison illustrates how similar the development of mining techniques, the types of equipment used, industrial and non-industrial buildings, transportation modes, and the emergence of attendant manufacturing facilities in England and Richmond were. It also points out that the industrial "frontier" arrived from England and quickly took hold in seventeenth and eighteenth-century Virginia, much quicker in fact than it had in England. This was in part due to the abundance of natural resources found in America.

TABLE 3

Comparison of English Mining Components 19th- Early 20th Centuries and Richmond Mining Components 1850-1939

Time Period	English Mining Components	Time Period	Richmond Mining Components
19th-early 20th Centuries	Mining techniques: primarily shaft mining; some rural surface collecting for domestic use. Widespread use of expensive equipment made collieries expand underground instead of on the surface. Viewers helped with safer mining conditions. Equipment: steam engines; diamond drilling; electric pumps; centrifugal fans; eletric winding machinery; screening, crushing, and washing plants. Coking ovens of brick. Buildings: engine housing of brick or stone; foundations of brick or stone; air shafts of wood, brick, or stone; machine, blacksmith, carpenter shops, bath house, worker housing (rowhouses), company stores, offices. Transportation: canals superceded by railroads. Railroads accessed by colliery tramways. Railroads opened new mining areas rejuvenating the industry. Attendent Manufacturing Facilities: numerous Ironworks	1850-1939	Mining techniques: Primarily shaft mining; some rural surface collecting for domestic use. Localized use of expensive equipment; attempts to reopen closed mines met with numerous explosions. Equipment: steam engines; diamond drilling; eletric pumps; centrifugal fans; electric fans. Limited need for coking ovens. Hand sorting and later machine sorting of coal by size, but no washing. Buildings: engine housing of wood, brick, or stone; brick or stone foundations; machine, blacksmith, carpenter shops, cook houses, company stores, hospital, churches, etc., Worker housing (rowhouse, barracks, 2 family units). Transportation: turnpikes, heavy use of railroads. Spur lines from pits to railroad were constructed. Attendent Manufacturing Facilities: Manakin Iron Works and Dover Coal Pits.

The technological advances and transportation developments available in England were also available in Richmond. However, in England the coal industry settled into symbiotic relationships with other industries which helped sustain the collieries, but in America, the industrial frontier kept moving past the Richmond coalfield until it hit the better quality anthracite field to the west, which had been opened by these same technological and transportation advances.

Despite the different longterm success of the English coalfields, and the relatively short-lived affluence of the Richmond coalfield, it is possible to draw explanations for archeological features found in the Richmond coalfield and to predict what resources would potentially be found at other, as yet unexcavated mine sites depending on their period of operation (see Tables 4, 5, and 6). The best way to illustrate the predictive model for the Richmond coalfield, drawn from the temporally analogous English mines, is a test application. Etna (Aetna) Hill, a coal mine site in operation during the first and second mining periods, has had archeological investigations and several archeological features were located that can be explained by the English coalfield information. The predictive model can also make "educated guesses" as to archeological potential and directions for further research at Etna Hill mine site, as in the larger sense the model can for the entire coalfield. The final portion of this chapter will then outline the predictive model's application to the Richmond coalfield, by mining periods. Future archeological and anthropological research concerns generated by this predictive model will also be examined.

TABLE 4

Potential Archeological Features at Richmond Coal Mining Sites: 1701-1794

Mining Component	Potential Archeological Features
Mining techniques: a) surface collecting b) shallow bell-pits c) trenches d) shafts	 a) basin-shaped depressions (to various depths) on the ground surface b) circular basin-shaped depressions, usually filled with ground water c) linear U- or V-shaped depressions (to various depths) d) circular basin-shaped depressions, with timber, stone, or brick shoring visible at or near the ground surface; usually filled with water
Equipment: a) ladders b) windlasses c) horse (mule) gins	 a) none b) possible post hole features adjacent to the shaft or pit c) possible post hole features adjacent to the shaft or pit, also circular track depression around gin from extensive erosion during the animal's continual circuits
Buildings: a) quarters for workers, slaves, and overseers	 a) brick or stone chimney footings, sometimes a brick or stone foundation; may see building divisions for two or more families
Transportation: a) intrasite road system b) natural waterways	 a) shallow linear depressions leading from the pits to nearest road or wagon path b) none
Attendent Manufacturing Facilities:	none in this period

TABLE 5

Potential Archeological Features at Richmond Coal Mining Sites: 1794-1850

Mining Component	Potential Archeological Features
Mining techniques: a) surface collecting b) shallow bell-pits c) trenches d) shafts	a) basin-shaped depressions (to various depths) on the ground surface b) circular basin-shaped depressions, usually filled with ground water c) linear U- or V-shaped depressions (to various depths) d) circular basin-shaped depressions, with timber, stone, or brick shoring visible at or near the ground surface; usually filled with water
Equipment: a) pumping and steam engines b) horse (mule) gins c) tramway coal cars	a) brick or stone foundations, probably partially or completely dismantled for repeated use elsewhere; if wooden shelter was erected, there may be sill or post hole features surrounding the foundation b) possible post hole features adjacent to the shaft or pit, also circular track depression around gin from extensive erosion during the animal's circuits c) none
Buildings: a) pump or steam engine housing b) miners' housing c) company buildings (non-industrial) d) company buildings (industrial)	a) foundations of brick or stone, or if wooden structure, sill or post hole features b) brick or stone chimney footings, sometimes brick or stone foundation; may see building divisions for two or more families c) brick or stone foundations of varying sizes located farther from the actual mine site d) brick or stone foundations of varying sizes, or if wooden structure, sill or post hole features; located close to the actual mine site
Transportation: (intrasite) a) private access roads b) tramways	a) shallow linear depressions that connect with either turnpike, canal, or railroad b) shallow, narrow linear depressions leading from mine to road, canal, turnpike, or railroad for tranportation
Attendent Manufacturing Facilities	a) industrial foundations of brick or stone; domestic complex of similar materials (see Appendix A: Dover Coal Pits/Manakin Iron Works)

TABLE 6

Potential Archeological Features at Richmond Coal Mining Sites: 1850-1939

Mining Component	Potential Archeological Features
Mining techniques:	
a) surface collecting	a) basin-shaped depressions (to varius depths) on the ground surface
b) shafts	b) circular basin-shaped depression, with timber, stone, or brick shoring visible at or near the ground surface; usually filled with water
Equipment:	
a) pump, steam engines, electric pumps	a) brick or stone foundations, probably partially or completely dismantled for repeated use elsewhere; if wooden shelter was erected, there may be sill or post hole features surrounding the foundation
b) diamond drilling	b) none
c) centrifugal, electric fans	c) only discernible as a circular void in standing walls; if ruins are not present then use of this equipment would be unknown
d) coking ovens	d) brick beehive ovens would leave foundation remains, with scorched earth beneath the coking feature
e) hand and machine sorting	e) possible brick or stone foundation for wooden structure over this area, wooden structure may have had no foundation, and therefore only post hole features would be present
Buildings:	
a) pump, steam engines, electric pump housing	a) foundations of brick or stone, or if wooden structure, sill or post hole features
b) miners' housing	b) brick or stone chimney footings and foundations; may see building divisions for two or more families
c) company buildings (non-industrial)	c) brick or stone foundations of varying sizes located farther from the actual mine site
d) company buildings (industrial)	d) brick or stone foundations of varying sizes, or if wooden structure, sill or post hole features; located close to the actual mine site
Transportation: (intrasite)	
a) private access roads	a) shallow linear depression that connect with eith turnpike, canal, or railroad
b) tramways	b) shallow linear depression leading from mine to road, canal, turnpike, or railroad for transportation
Attendent Manufacturing Facilities	a) industrial foundations of brick or stone; domestic complex of similar materials (see Appendix A: Dover Coal Pits/Manakin Iron Works)

Aetna Hill 44CF320

The Etna or Aetna Hill area had coal pits and shafts in operation between 1798 and the mid-1800s. The tract on which these pits and shafts are located was acquired in c1791 by Thompson Blunt (Blount), through his marriage to Fanney Morrissette Blunt (of Huguenot descent). The land had originally been granted to John Tullit (a Huguenot) by King William (Chesterfield County DB2:35).

Blunt built a one-and-one-half-story house for his wife and young family on this tract. With naturally occurring coal outcroppings, it was not long before Blunt noticed the potential for profit on his own land. Prior to mining commercially, Blunt may have extracted coal for domestic purposes from shallow bell-pits near where Falling Creek passes through his property. In 1798, Blunt and his neighbor, Harry Heth, agreed to mine coal found on Blunt's property (Henry Heth Papers). These mines were subsequently leased by Wills, Brown, and Company, and later were leased by Heth, and finally by the Etna Coal Company sometime after 1836 (Chesterfield County DB31:308).

In 1831, the 72 acres on which these mines are situated passed to the Blunts' daughter, Maria and her husband, Elijah Brummall (Chesterfield County DB28:403). Blunt also conveyed one-quarter of the mineral rights but retained three-quarters of the rights and "full privilege of searching for and mining for coal upon said land and the temporary use of a sufficiency of the soil for such mining purposes" (Chesterfield County DB28:453-454). Elijah Brummall continued to manage mining operations at the coal pits after Thompson Blunts death in 1844. He also constructed a two-and-one-half-story addition to the original Blunt house in c1834.

One shaft operated by Wills, Brown, and Company, and later Heth, and finally the Etna Company (formed in 1836) extended to a depth of 400 feet, with two inclines, extending the total depth to 700 feet. One incline was worked by mule power, while the other by a Boulton and Watt steam engine situated at the shaft base. A second steam engine was situated at the pithead (Eavenson 1942:107).

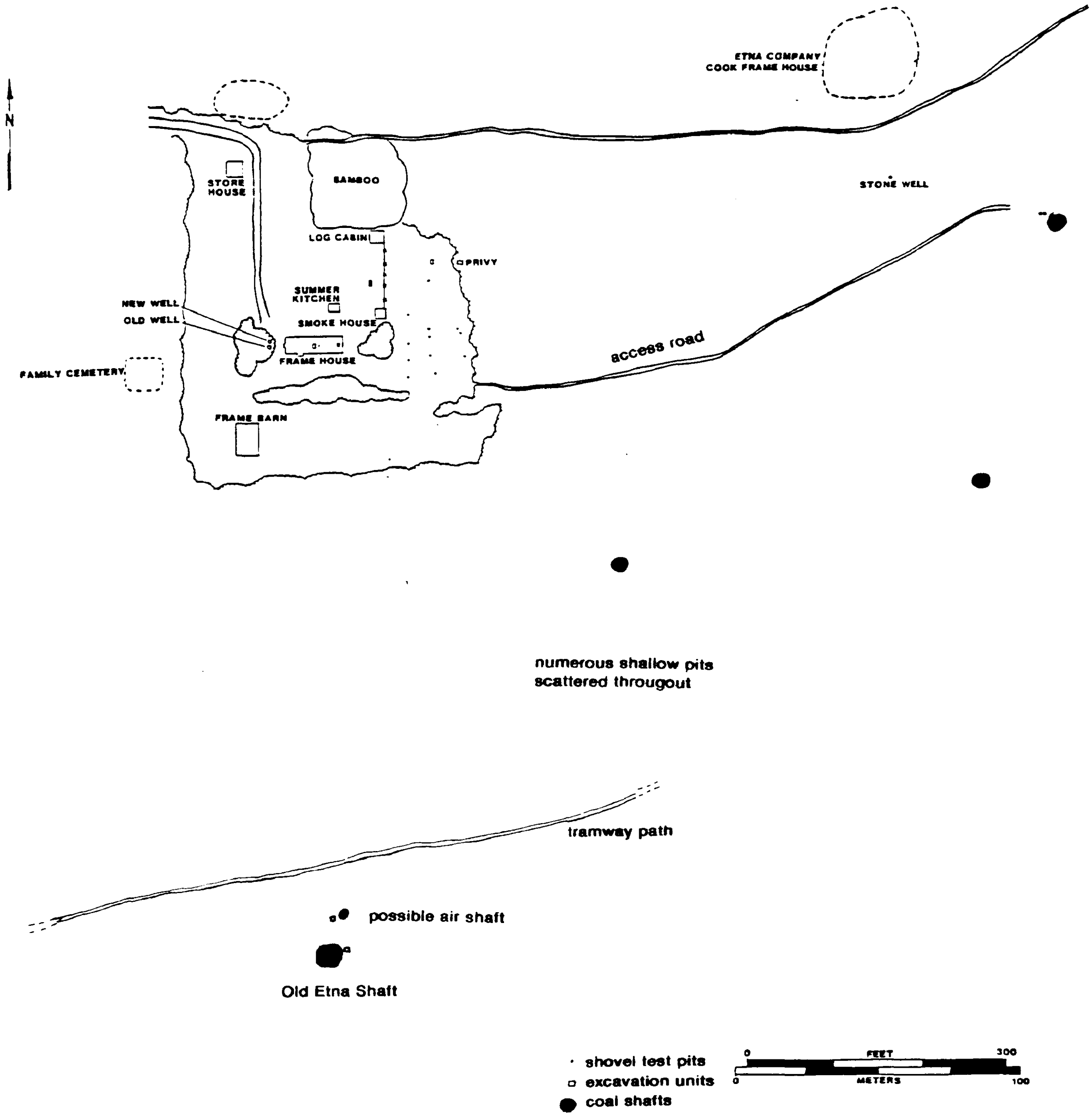
A total of 90 hands, primarily slaves, as well as Newcastle "ventilators" were employed at the mines (Wooldridge 1841:1-14). The Etna Company coal was described as being of "superior quality for smitheries" (Eavenson 1942:107). By 1837, the colliers at this mine had supplied the market with 300,000 bushels and were increasing yearly. In the 1840s, English ventilators and managers helped manage the mine. The coal from the Old Etna shaft was later exhibited in the 1884 World's Industrial and Cotton Exposition held in New Orleans as a prime example of bituminous coal (Weaver 1962:42).

The domestic portion of the Blunt/Brummall estate consisted of a main house of frame construction, with several outbuildings. Structures such as the smokehouse, log slave cabin, pole barn, and summer kitchen (c1830s), were built to serve the domestic needs of the Blunt family (Figure 16).

Other structures were directly related to the mining activities, which literally occurred in the backyard of the main house. These structures include an extant brick structure used during the late nineteenth and early twentieth century as a barn for animals and hay storage (Bettie Weaver, personal communication 1987); however, during the

Figure 16

Plan of Aetna/Etna Hill (44CF320).



mining period, this most likely served as a locked storehouse. The small size (17 by 20 feet) and absence of windows indicate an initial function other than a barn. The mine company store was also located north of the main house (Bettie Weaver, personal communication 1987). This store would have served miners employed at the coal pits, providing them with dry goods, food, and clothing, by honoring the tokens received as payment for mining. A number of bricks scattered on the ground surface indicates that the structure was probably of frame construction with a brick chimney, and possibly a brick foundation. During the nineteenth-century, the Etna Company cook house was established northwest of the main house, with a stone-lined well located downslope from the site (Bettie Weaver, personal communication 1987). The cook would have been responsible for daily meals for the colliers and managers employed in the mines.

During the initial archeological survey, this site was designated 44CF320 (Opperman et al 1987; Traver et al 1988). A total of six excavation units were situated in areas directly related to mining activities at the site, with the goal of gathering information concerning the techniques and machinery involved with the mining operations at Aetna Hill.

A five-foot square excavation unit was placed near the edge of the Old Etna shaft to ascertain whether the use of a horse gin, or some type of animal-powered winding gear could be found archeologically. This excavation unit indicated that overburden removed during mining had been deposited directly around the perimeter of the shaft, creating a tailings pile. No archeological features were located. The artifacts recovered from the first 0.3 feet gave a post-1840s date, with the underlying culturally sterile layers being composed of shale, loose sandy soil, and small waste coal.

Two excavation units were placed on piles of brick rubble near the Old Etna shaft to investigate the possible presence of machinery foundations and engine housing features. The first excavation unit (five feet square) contained no cultural deposits beneath the brick, which had probably collapsed from a nearby brick structure. The second excavation unit (five feet square) contained an exterior brick wall aligned east-west; the machine-made brick and associated artifacts dated the feature to the nineteenth century. At a depth of three feet, a soil feature was revealed. This feature appears to have served as a drainage ditch for the building foundation it is associated with. The foundation most likely served as a stable platform for a steam or pump engine, which would require a ditch to direct water away from the mine shaft.

A smaller shaft was located approximately 50 feet north of the Old Etna shaft. This probably served as an air shaft, or possibly an escapeway. If it served as an air shaft, there were no archeological remains located within the five-foot square excavation unit placed near the shaft. This may be indicative of a wooden structure placed over the engine rather than a more substantial one of brick or stone.

Another large coal pit was located approximately 700 feet east of the main house. A concentration of brick was visible on the surface, as well as a scatter of late nineteenth- and early twentieth-century artifacts. A three-by-six-feet excavation unit was placed in alignment with what appeared to be the axis of the visible brick foundation. This excavation unit revealed two parallel brick walls spaced 2.5 feet apart, with a concrete floor. A lead pipe was located at floor level, adjacent to the south wall. A second excavation unit, three-foot square, was opened to the northeast to determine if a bulkhead entrance existed. Excavation of this L-shaped unit revealed the two parallel handmade brick walls were without a bulkhead entrance. Artifacts recovered indicate that the foundation was abandoned, and subsequently filled during the late nineteenth and early twentieth century. This foundation also probably served as a platform for a steam or pump engine situated at the pithead.

The remnants of an intrasite transportation feature were also located. A coal tramway is evident near the Etna Shaft appearing as a shallow, linear depression. The wooden tracks, long since rotted away, would have been covered with iron. The iron, like all the other available scrap metal, was sold prior to World War II (Bettie Weaver, personal communication 1987). The tramway helped get the extracted coal in cars to a screening area along the tramway where dirt and rocks in the coal were removed. The tramway would have then been used to help push the coal toward the loading area. The tramway connection with the adjacent railroad (Norfolk Southern Railroad) could not be determined, and it probably predates the railroad. If so, the tramway connected with Midlothian Turnpike (Route 60) and the coal was transported to Richmond in wagons. An earlier private access road installed by Thompson Blunt in 1806, which connected his coal pits with Midlothian Turnpike, was not located (Figure 17).

Aetna Hill Interpretation

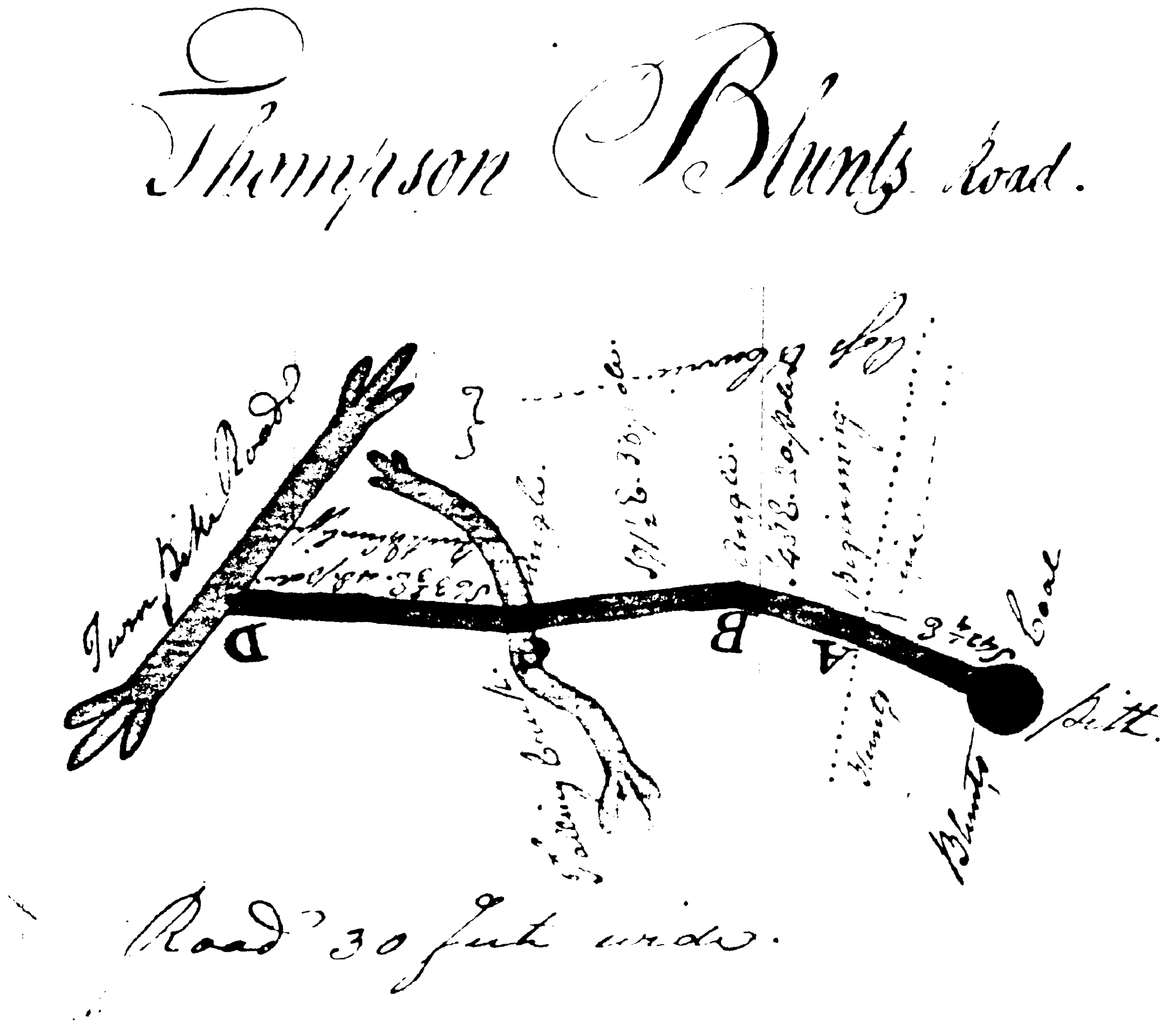
The site commonly known as "Aetna Hill," by both its current residents and the majority of Midlothian, Virginia, contains cultural deposits related to several different aspects of coal mining in the late eighteenth and nineteenth centuries. The domestic component "Aetna Hill" stands on its own merit as one of the few extant, continuously occupied eighteenth-century houses in Chesterfield County. It was also the home of a successful mine operator during this period. However, the mining activities that occurred on the tract are not as fully documented.

The earliest mining by Thompson Blunt after 1791 may be represented by three small, shallow water-filled pits located adjacent to Falling Creek. These pits were most likely exploited for domestic use, excavated by hand and loaded into baskets or wagons, with a wagon path adjacent to those pits. It is doubtful that these pits extended any deeper than 15 to 20 feet due to the proximity of Falling Creek and the level of the water table.

The later two shafts represent more intensive use of machinery to make coal mining a successful and lucrative business. The predicted engine foundations were located adjacent to each of these two pits. However, the more ephemeral use of horse, or mule, gins was not located.

Figure 17

Surveyor's plat of Thompson Blunt's Road which connected his coal pit with Midlothian Turnpike. This was surveyed by William LaPrade in September 25. 1806 (Chesterfield County Courthouse).



The archeological mining features located during preliminary testing of the Aetna Hill site were explained by oral tradition, historical references, and confirmed by information gained from analogous English mine sites. Further research at the site should attempt to locate the outlying remains of ancillary structures that, based upon the predictive model for the period 1794-1850, should be present (see Table 6). This would include a large number of workers' housing, overseers' housing, and possibly a machine shop and a blacksmith's shop.

Predictive Model Applications for the Richmond Coalfield

The majority of mining sites throughout the United States are located on public lands, and therefore subject to and protected by federal and state management policies and laws. All public land agencies must comply with the National Historic Preservation Act of 1966 and its 1980 amendment, and the National Park Service is directed by Public Law 94-429 (Mining in the National Parks) and 35 Code of Federal Regulations, Part 9. Therefore, the mining sites on federal land are somewhat protected from disregard and destruction by these laws. However, the existence of the 1872 General Mining Law which states, that "...all valuable mineral deposits in lands belonging to the United States...[are] free and open to exploration and purchase," often creates problems between modern mining and historic mining sites (see Maley 1983; Turner and Armentrout 1986). Public land managers have used a statement within the 1872 law that mentions the right to "exploration and purchase" of mineral deposits must be exercised within "regulations proscribed by law, and...not inconsistent with the laws of the United States" (Turner and Armentrout 1986:7; Hardesty 1988:105).

However, these laws, regulations, and fears of any interest in reopening historical mines have little in common with the current situation in the Richmond coalfield. The majority of the land on which these coal mine sites are located is privately owned and, therefore, not generally subject to even the minimal protection federal laws offer to historically significant sites. While there is little interest in renewing the mining industry in Richmond, as there is in the western United States, nevertheless, the Richmond mine sites face potential destruction from the private sector. As the area surrounding Richmond continues to grow, commercial and industrial developments are being constructed over one of the earliest commercial industries in the United States.

With developments encroaching upon the mine sites, the Division of Mine Land Reclamation has been called to cap off these "attractive nuisances." In an effort to disturb as little archeological information surrounding the open mine shafts as possible, the Division has asked for historical and archeological assistance to determining what types of archeological features and cultural resources could be encountered at the sites. This predictive model was developed with such an application in mind.

In the predictive model the mining sites in the Richmond basin are best divided into three temporal periods: the first period between 1701-1794, the second between 1794-1850, and the third period between 1850-1939. Within each mining period, four components of the actual industrial process of mining will be discussed (see Tables 4, 5, and 6). The components will be further discussed as they relate to economic considerations at large and small-scale coal mining operations.

The first component of mining are the types of excavations used to reach the coal, such as trenches, pits, and shafts, and the methods of shoring these excavations that are visible on the ground surface. The second component are types of equipment and buildings (industrial and non-industrial) that would have been used at the sites, leaving stone or brick foundations on the ground surface. There would have been various pieces of mining equipment, some requiring protective housing structure (industrial structures). The mining buildings (non-industrial) would include colliers' housing, company stores, as well as the equipment housing. Third, the types of transportation available to take the coal from the pithead area to market. These could include water transportation, (canals and natural waterways), privately-constructed access roads, public turnpikes, privately constructed tramways (for pushing small coal cars to more major forms of transport), and later railroads and their spurlines. The fourth and final component of mining sites are attendant manufacturing facilities that utilized the coal extracted nearby, producing a symbiotic industrial relationship.

Predictive Model for Coal Mining Sites in the Richmond Basin: 1701-1794

During the first period of coal mining in the Richmond basin, 1701 to 1794, the efforts were primarily toward the domestic market in Richmond and the surrounding countryside. With the exception of the American Revolution, England still exported large quantities of coal to the eastern seaboard area. The American population, in large, seemed to hold the English coal, especially from the northern Newcastle mines, in very high esteem. For these reasons, the Richmond mining efforts were typically small operations of between two to five men, or family members, shoveling coal from outcroppings. The outcrop was followed horizontally as a trench, and vertically to a depth of approximately 20 to 25 feet. Outcrops were also mined with shallow pits, similar to the English bell-pits, which were excavated until it was no longer safe, and filled in with debris from the next pit opened. These circular pits varied between five feet ten inches and sixteen feet in diameter.

Mining sites of this period used little equipment beyond shovels, picks, and mule-gins (whim gins, windlass) to extract the coal. The horse or mule-powered winding equipment would leave an ephemeral archeological record at best, with only post holes marking it's previous location. This equipment was portable and fairly weather-resistant, and would have needed no housing structure. As the mining operations became more intensive toward the end of the eighteenth century, stables may have been built nearby for the mules and horses.

The remaining buildings of this period included slave quarters and overseers' houses. These structures would have been erected at mine sites that were producing coal on a larger scale, such as the Black Heath Pits, Wooldridge's Pits, and Graham's Pits. The dwellings were typical of other comparable Virginia structures of this time period, with frame or log construction and brick or stone chimneys, and sometimes foundations. If present at an eighteenth-century mine site, these structures would have been clustered fairly close to the pits.

Transportation components of this period include some limited use of natural waterways by mines fortunate enough to be located nearby. The majority of the coal was transported in wagons and carts overland on public roads and turnpikes. There were also cart paths from the pit head to the public roads. During the rainy season these roads were impassable, rendering coal mining a seasonal occupation until better transportation was constructed.

Richmond Mine Sites: 1701-1794

During this period, coal mining activities were conducted at the following sites (Table 7). The mines with several names may have been known by anyone of these throughout the period of mining operations; however, when possible, the names are listed chronologically. The majority of the information for Tables 7, 8, and 9 was obtained from the recent work of Gerald Wilkes (1988), with substantial contributions from Howard Eavenson's 1942 research on coal mining in the United States. The work of geologists Shaler and Woodworth (1899) was invaluable, providing stratigraphic information concerning the Richmond basin, as well as late nineteenth-century plan maps of several mine sites.

Virginia state archeological site numbers for the mines are also included when appropriate. The number associated with each mine indicates its placement on Figures 18, 19, 20, 21 and 22 located at the end of this chapter (see also Appendix A).

Table 7

<u>Carbon Hill District</u>

10. **Woodwards Pits, Lucy White Tract Pits** (44GO256) - operated between c1762-1911.
11. **Tuckahoe Pits, Tuckahoe Shaft** - operated between the late 1780s and the Civil War.

<u>Deep Run District</u>

** **Deep Run Pits, Springfield Pits, Duval's Pits, Burton's Pits, Ross & Curry Pits, Barr's Pits** - operated between c1761-1924.

<u>Midlothian District</u>

14. **Trabeau Pits, Burfoot Pits, River Pits** - operated between c1778-c1841.
16. **Salle's Pits** - operated between 1730 -1841.
20. **Black Heath Pits, Chesterfield Mining Company Pits** - operated between c1788-1855.
26. **Ellyson's Pits, Wooldridge Pits, Old Midlothian Pits, Road Shaft** - operated between c1765-c1838.
31. **Railey Pits, Mills Pits, Mills, Reid and Company Pits, Mills Creek Pit, Mills & Reid Creek Pit** - operated between the late 1700s- c1841.
34. **Greenhole Shaft** - operated between c1790-c1841.

<u>Huguenot Springs/Manakin District</u>

** **Graham's Pits, Anderson and Moody's Pits, Dover Pits** - operated between c1790s-c1865.

62. **Storehouse Shaft** - discovered 1701; operated between c1750-c1865.
64. **River Pits** - operated between 1700s-c1860.

Predictive Model for Richmond Coal Mining Sites: 1794-1850

During the second period of mining, 1794 to 1850, the Richmond coalfield prospered and reached its peak. The 1794 tariff on imports, including English coal, left a market to be filled. This tariff enabled Richmond mine owners to effectively corner the market on coal, allowing expansion to meet demand. Indeed, mine owners who did not have or put money into expansion, such as technologically-advanced equipment and slaves, would be forced out of business by those who did reinvest in their mines. During this period, English mine owners and operators had been persuaded to join forces with other profit-minded individuals to obtain enough capital to purchase the more expensive machinery needed to keep pace with the industry. The Richmond coal mine owners were in the same situation. Equipment, slave labor, mine engineer consultants, and coal land were expensive in Richmond, leaving men no choice but to form partnerships and companies, and then later to incorporate to generate needed capital. Nevertheless, the small mine owners still existed within the Richmond basin during this period. Instead of attempting to make their fortunes, they merely attempted to fill a small local market, just as the smaller mine operators had done in England with the land-sale coal

It was also during this period that English miners and engineers began to appear on the Richmond landscape. Harry Heth's visit in the first decade of the nineteenth century to England resulted in an association of longstanding between mine owners in both countries. By the 1840s, mine engineers clearly stated that they were establishing the under- and above-ground workings in Richmond in the manner found in the Northeast of England (Wooldridge 1841). Colliers from England worked alongside the free black, slave, and white males forming the basis for reaching the peak of production within the Richmond coalfield.

The planning and excavation of Richmond mines became less haphazard than the mining done during the first period. The majority of the nineteenth-century mining was done underground from shafts with gangways periodically branching off toward the coal seams. These shafts were excavated deeper, with the shoring and tubbing of the shaft consisting of hewn timbers, and sometimes brick or stone. The shafts were probably circular between five and fifteen feet in diameter, or sometimes square shafts of six feet based on their English counterparts. Shafts were still excavated at known outcrops because the geology of the Richmond basin was still not understood well enough to risk sinking a shaft and missing the coal due to a geologic unconformity.

The equipment used in this period varied greatly depending on the economic standing of the mine owner. At smaller mines, the animal-powered windlass would have sufficed for hauling up water and coal. The larger operations would have used a combination of windlasses and steam engines. The steam engines, in various horsepowers, were expensive investments and as such, required more care and upkeep than mules or windlasses. Foundations of brick or stone were laid to keep the engine off the ground, both for draining engine water and to keep the engine from rusting. Wooden frame structures were also constructed to keep the weather from affecting the engines. As the steam engines were moved from shaft to shaft, the foundations and structures could have also been dismantled and moved as well. Archeologically, this pattern of use and reuse can be confusing, with only ephemeral features, such as sills and post holes, remaining to indicate the presence of these pieces of equipment.

The larger operations also constructed other colliery buildings. Housing for the mine overseers and quarters for the slaves was an increasing concern. As a good portion of the slaves were leased from their masters, these slaves may have been housed in barracks-type buildings, such as the Brick Rowhouse in Midlothian (O'Dell 1986). Other quarters, typical of other slave dwellings of the period, would have been for slaves owned by the colliery, with families, who also worked at the mines. The miners' dwellings at Railey Hill and the Grove Shaft are indicative of this type of housing, with two separate families occupying a single brick or frame structure. Cook houses would have been necessary to feed the colliers, and there is reference to a "Cook House" at the Etna Company mines (Bettie Weaver, personal communication 1987). These buildings would have been clustered fairly near the shafts. Domestic housing provided at colliery sites was located at the site of the Dover Mines. At least three dwellings have been tentatively identified based on a c1845 map of the Manakin Iron Works (see Figures13 and 14). One of the dwellings appears to have been of the barracks-type design, while the other two are slightly smaller, perhaps for two separate families.

Company buildings, offices, and stores were also built near the shafts. Company buildings may have served to store equipment, while the offices provided shelter for company clerks and records. The company stores, such as those at the Midlothian and Etna Collieries, would have served the miners as general stores, accepting company tokens in lieu of script. These stores often later became general stores for the community, such as the Midlothian General Store run by the Wooldridge family.

Improvements in transportation allowed the expansion of the collieries. The construction of canals, such the James River and Kanawha Canal, provided a less expensive and damaging trip for the coal to market. Smaller canals, such as Tuckahoe Canal (44GO255), were excavated by canal companies composed mainly of coal mine owners. These canals allowed access to some coal mines situated nearby, however, they were plagued with periods of insufficient water supplies, making the availability of water transport a capricious commodity. In England, canals were the key that unlocked the potential of coal mines in the interior; in Richmond, canals were often unpredictable and unreliable. Access roads were constructed to coal mines to take the place of canals because when the canals were full of water the roads were impassable. Private access roads, such as Railey's, Blunt's, and Buck's, served several coal mines (see Figure 17). These roads were no more than wagon or cart paths and are visible as slightly depressed winding paths connecting turnpikes and coal pits. Roads of this nature would necessarily be present at all coal mining sites and linked up with the turnpikes. Public turnpikes were being constructed at the request of coal mine owners and the general public. Railroads, like turnpikes, were financed by companies comprised of mostly mine owners, with shares sold to the public.

Private tramways, or small-gauge railways, were constructed at some of the larger collieries. Tramways allowed the coal cars at the pit head to be pushed by hand to waiting wagons or canal bateaux. Wooden rails provided stability for the cars. Tramways are present at mine sites as small, narrow linear depressions. Archeological evidence of such a tramway was located at the Blunt/Etna Company mine site (Hernigle 1987, 1988).

Attendant facilities were first built during this mining period. Attendant facilities include industries that consume coal produced nearby, such as would later be successfully developed in England. At present, the only two sites known that include coal mines and associated industrial facilities are Major Clarke's Pits and the Bellona Arsenal/Foundry, and the Dover Coal Pits and the Manakin Iron Works. Maj. Clarke's Pits, perhaps also known as the Bellona Arsenal Pits, operated between 1810 and 1832. The coal produced at these pits was sent to the Bellona Arsenal and to Clarke's nearby Bellona Foundry to fuel the forges for casting armaments. Little beyond this is known through historic documents of the period.

The Manakin Iron Works was constructed adjacent to the Dover Coal Pits in c1845. The industrial complex is situated south of the James River and Kanawha Canal and the domestic/coal mining area is on the north side of the canal (see Figures 13 and 14). The industrial complex utilized the coal for its forges and steam engines. While this combination of coal-producing mines and coal-consuming industrial facilities seems to be a sound concept, it apparently worked for only a short time. The Manakin Iron Works closed in 1855, although the facilities were probably used during the Civil War when Christopher Q. Tompkins supervised the coal mining at Dover for the Confederacy (Tompkins Family Papers). Further historic research may provide insight into the symbiotic industrial relationship between the coal and iron industries in Richmond as evidenced at this site.

Richmond Mine Sites: 1794-1850

During this period, 1794-1850, coal mining activities were conducted at the following sites (Table 8). The mines with several names may have been known by anyone of these throughout the period of mining operations; however, when possible, the names are listed chronologically. Virginia state archeological site numbers are also included when appropriate. The number associated with each mine indicates its placement on Figures 18, 19, 20, 21 and 22 located at the end of this chapter (see also Appendix A).

Table 8

Carbon Hill District

1. **Saunders Shaft** - opened early 1800s, unknown closing date.
3. **Turpius Colliery, Magruder Pit, Maggi Pit** - opened before the Civil War and closed in the late 1880s.
4. **Gayton Shaft, Coke Shaft, Orchard Shaft, Twin Shaft, Double Shaft, Breaker Shaft** - operated between 1819 and 1912.
5. **Edge Hill Shaft** - opened before 1841 and operated at least until 1847.
6. **Barbershop Shaft, Railroad Shaft** - unknown dates of operation.
8. **Trent Slope, Mule Shaft, Engine Shaft, Carbon Hill Mine, Joseph R. Anderson & Company Mine, Coalbrooke Slope, Old Dominion Development Company No.1 Mine** - operated between c1848-1944.
9. **Cottrell's Pits** - operate between c1835-c1846.
10. **Woodwards Pits, Lucy White Tract Pits** - operated between c1762-1911.
11. **Tuckahoe Pits, Tuckahoe Shaft** - operated between the late 1780s and the Civil War.
12. **Tippecanoe Shaft** - operated between c1841-1860.
13. **Wickham or Wigham Pits** - closed before Civil War.
14. **Anderson Pit, Graham Pit** - opened before 1840.

Deep Run District

** **Deep Run Pits, Springfield Pits, Duvall's Pits, Burton's Pits, Ross & Curry Pits, Barr's Pits** - operated between c1761-1924.

Midlothian District

14. **Trabeau Pits, Burfoot Pits, River Pits** - operated between c1778-c1841.
15. **Major Clarke Pits** - operated between 1810-1832.
16. **Salle's Pits** - operated between 1730 -1841.
20. **Black Heath Pits, Chesterfield Mining Company Pits** - operated between c1788-1855.
21. **Buck & Cunliffe Pits, Buck Pits, Cunliffe Pits** - operated between c1820s-1842; 1880s.
23. **Gowrie Shafts** - operated between c1821-c1841.
24. **Blunt Shaft, Thompson Shaft, Wills Shaft, Willis & Michaels Shaft, Aetna Shaft, Etna Shaft** - operated between 1798- mid 1800s.
26. **Ellyson's Pits, Wooldridge Pits, Old Midlothian Pits, Road Shaft** - operated between c1765-c1838.
27. **Bailey Pits** - operated between c1800s-c1860.
28. **Hanson Shafts** - opened early 1800s, unknown closing date.
30. **Maidenhead Pits, English Company Pits, Heath Pits** - opened c1821, unknown closing date.
31. **Railey Pits, Mills Pits, Mills, Reid and Company Pits, Mills Creek Pit, Mills & Reid Creek Pit** - operated between the late 1700s-c1841.
32. **Bell Shaft** - opened before c1823 and abandoned after c1923.
33. **Union Pits** - operated c1824-c1839. Reopened in 1880.
34. **Greenhole Shaft** - operated betweeen c1790-c1841.
35. **Pacebri Pit** - opened before 1840, unknown closing date.
37. **White Chimney Shaft, Old Midlothian Pit** - operated between 1800s-1856; 1858-1861.
39. **Pump Shaft, Midlothian Shaft, Middle Shaft** - operated between c1836-1869.
40. **Grove Shaft, Murphy Slope** - operated between c1836-late 1880s; 1902-1904; 1920-late 1920s.
42. **Creek Company Pits** - operated between c1837-1840s.
43. **Stonehenge Pits** - operated between 1796-1832; 1848-1896.
44. **Woods Shaft**- operated between c1836-1876.

** **Bolling (or Boiling) Pit** - operated between

1842-1880.

** **Lauree Pits, Laurel Pits** - operated during the late 1830s.

<u>Clover Hill District</u>

46. **Coate's Pits** - opened early 1800s, unknown closing date.
47. **Hill Shaft** - operated between c1822-1828.
48. **Cox Pits, Clover Hill Pits** - operated between c1839-late 1800s.
49. **Moody and Johnson Pits** - opened before c1840, unknown closing date.
52. **Bright Hope Shafts** - operated between 1844-1889.
57. **Rowlett Pits, Appomattox Company Pits** - operated between c1820s-late 1840s.

** **Dupuy and Powell's Pits** - operated during the early 1800s.

<u>Huguenot Springs/Manakin District</u>

** **Graham's Pits, Anderson and Moody's Pits, Dover Pits** - operated between c1790s-c1865.

58. **Locust Shaft** - operated early 1800s, unknown closing date.
60. **Deep Shaft** - opened early 1800s, unknown closing date.
61. **Aspinwall Shaft** - operated between mid-1800s-early 1900s.
62. **Storehouse Shaft** - discovered 1701; operated between c1750-c1865.
63. **Canal Shaft** - opened before early 1800s, unknown closing date.
64. **River Pits** - operated between 1700s-c1860.
65. **Towne Pit, Towne & Powell Pit** - opened early to mid-1800s, unknown closing date.
67. **Norwood Mine** - may have opened as early as 1835; operated between c1878-late 1880s.
69. **Powhatan Pits, Finney's Pits** - opened early 1800s, unknown closing date.
71. **Old Dominion Pits** - operated between early 1800s-c1885.

Predictive Model for Coal Mining Sites in Richmond Basin: 1850-1939

During the third and final period of mining in the Richmond basin, coal production was slowly, but steadily declining. The gaseous nature of the Richmond mines caused repeated explosions, leaving consumers suspecting the coal itself. Also after the 1830s, better quality coal from western Virginia, Maryland, Pennsylvania, and later West Virginia became increasingly available to consumers.

There was no change in the manner in which mines were excavated at collieries during this period. The internal layout still varied from mine to mine, based upon the geologic conditions. However, the surface layout became increasing complex. Steam engines of larger horsepower, covered with wooden frames, resting on brick or stone foundations, were evident across the mining landscape. Blacksmith's shops and machine shops at collieries were needed to repair the machinery.

Housing for colliers during this period was provided by the company. Prior to the Civil War, the slaves were housed in quarters and barracks, and after their emancipation, free blacks occupied the same housing, paying rent to the company. It is during the late nineteenth and early twentieth centuries that colliery housing changed a great deal. Gayton Village, consisting of company-owned houses, is the only known example of company-owned housing on the larger scale of Pennsylvania and West Virginia anthracite coal housing. The site has been subsequently destroyed by modern development.

Industrial structures at the collieries also changed by the early twentieth century. The equipment at the Grove Shaft provides a good example of new technologies introduced to the Richmond coalfield. A tipple building (for processing the coal), large coal bins for storage, engines and winding houses, and an office building were erected in the 1920s. These structures were constructed of natural stone, with scattered bricks incorporated into their fabric (probably from dismantled machine foundations). Twentieth-century mining at eighteenth- and nineteenth-century mining sites, most likely has obliterated the traces of earlier mining.

Richmond Mine Sites: 1850-1939

During this period, 1850-1939, coal mining activities were conducted at the following sites (Table 9). The mines with several names may have been known by anyone of these throughout the period of mining operations; however, when possible, the names are listed chronologically. Virginia state archeological site numbers are also included when appropriate. The number associated with each mine indicates its placement on Figures 18, 19, 20, 21, and 22 located at the end of this chapter (see also Appendix A).

Table 9

Carbon Hill District

2. **Eureka Shaft** - opened by c1853, unknown closing date.
4. **Gayton Shaft, Coke Shaft, Orchard Shaft, Twin Shaft, Double Shaft, Breaker Shaft** - operated between 1819 and 1912.
7. **Deep Shaft, Air or Shelter Air Shaft, Snead's Shaft, Crouch & Snead's Shaft, Crouch's Pit, Brooke Shaft** - operated between c1851-c1865; c1873-1875.
8. **Trent Slope, Mule Shaft, Engine Shaft, Carbon**

Hill Mine, Joseph R. Anderson & Company Mine, Coalbrooke Slope, Old Dominion Development Company No.1 Mine - operated between c1848-1944.

10. **Woodwards Pits, Lucy White Tract Pits** - operated between c1762-1911.
17. **Sycamore Shaft** - abandoned by 1888.

<u>Deep Run District</u>

** **Deep Run Pits, Springfield Pits, Duvall's Pits, Burton's Pits, Ross & Curry Pits, Barr's Pits** - operated between c1761-1924.

<u>Midlothian District</u>

18. **National Industrial Engineers Incorporated Strip** - operated between 1938-c1940.
19. **Bingley Slope** - operated between 1861-1865.
22. **Jewett Coke Shaft** - operated between c1882-1899.
29. **Woodrow Pit** - opened before 1900?, unknown closing date.
32. **Bell Shaft** - opened before c1823 and abandoned after c1923.
36. **Agaze Shaft** - opened in 1873, unknown closing date.
38. **Sinking Shaft** - operated between c1865-1869.
40. **Grove Shaft, Murphy Slope** - operated between c1836-late 1880s; 1902-1904; 1920-late 1920s.
45. **Dinny Pit** - opened before c1900, probably worked into early 1900s.

** **Bellona Arsenal Shafts** - unknown dates of operation, although probably Civil War period.

** **Hill's Pits** - operated and abandoned before 1860.

<u>Clover Hill District</u>

50. **New Slope** - opened before c1890, unknown closing date.
51. **Beaver Slope** - operated in 1877, unknown closing date.
53. **Pump Slope** - opened in 1880s?, unknown closing date.
54. **Hall's Pits, Halls Retreat Slope** - operated between 1867-1889.
55. **Raccoon Slope** - operated between c1863-1884.
56. **Rudd Mine** - operated summer and fall seasons in 1920s.

Huguenot Springs/Manakin District

59. **Gate Shaft** - opened before 1860, unknown closing date.
66. **Bladon Pits, Scott Pits, Woodward Pits, Kennen Pits, No. 13 Slope** - opened and closed during 1880s.
70. **Chesterfield Coal Company Pits** - opened c1932-c1940s.

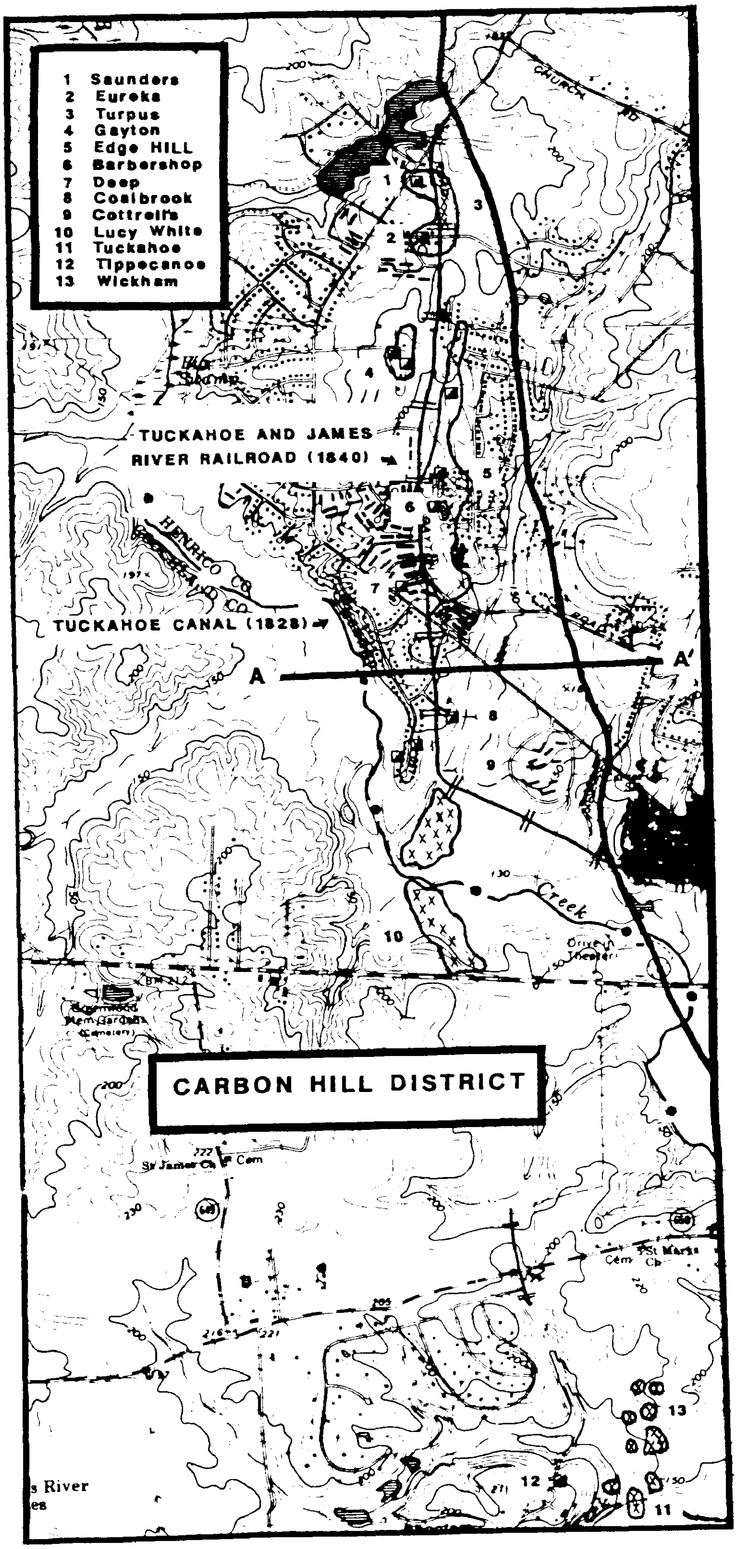
Conclusion

The coal mining operations in the Richmond basin never approached the scale, longevity, or level of success of their English counterparts. However, it was not from lack of effort. Richmond coal mine owners adopted English mining methods (as they suited the specific geologic conditions), they purchased the recommended equipment for ventilating and hoisting their mines, and they provided company housing and amenities to attract and keep workers. Nevertheless, the very nature of the coal they hoped would make their fortunes proved to be their undoing. The bituminous coal was quick to burn, with clouds of noxious smoke heralding it's use on the landscape. Blacksmiths and other industrial consumers of coal preferred this coal because it was easily lit; however, once anthracite coal was available and it's properties understood, industrial and domestic consumers purchased this smokeless, hot-burning coal. The railroads accessing the anthracite coal in Pennsylvania and West Virginia made the hard coal even less expensive to the consumer. The railroads' expansion and continual explosions in the gassy bituminous coal seams in Richmond dealt the mines their death blow. The ruins of this industry dot the landscape.

The information gained from analogous geologic and historic conditions in England, has demonstrated how and why mines are distributed across the geologic landscape, as well as their temporal and technological changes. The predictive model has also compared historic documentation with archeological evidence (when available) concerning mining methods and equipment used; and finally, it has allowed the generation of predictions and possible explanations for mining activities and their archeological remains. The model has also determined that of the three variables used in the predictive model -- geologic conditions, temporal setting of the mine, and economic status of the mine owner -- that economic status is probably a far more reliable indicator of potential archeological resources at a given mining site. The final phase of all predictive model theories must always be archeological or historical confirmation, or denial, of the proposed model. As with all predictive models and hypotheses, it is difficult to determine success, failure, or more likely the necessary modifications needed to refine the model, without adequate testing. However, this predictive model designed for the Richmond coalfield has had only limited archeological confirmation of its basic tenets. Additionally, traditional types of historical research at each mining site would also prove invaluable, as evidenced by the specific types of information found at selected sites (see Appendix A). It is believed, however, that further archeological exploration of the Richmond mining sites would bear out the precepts of the predictive model, with the refinement of modeling techniques and their specific applications.

In a more general sense, historic research of the Richmond mines may prove illuminating in a larger cultural context. In particular, the slaves who labored in the mines had far greater freedom than did those who worked under closer supervision on farms, and especially the plantation setting. Would this increased freedom and semi-equal status within the mines be transferred to the slaves' homes, and would this cultural phenomena be visible within the archeological record? This type of research could have far reaching effects on cultural anthropology and also archeology. Further archeological exploration of the Richmond mining sites could be focused on questions concerning slave status and acculturation, as well as the transplantation of the Industrial Revolution in Richmond.

Figure 18



Map of the Carbon Hill mining district (After Wilkes 1988).

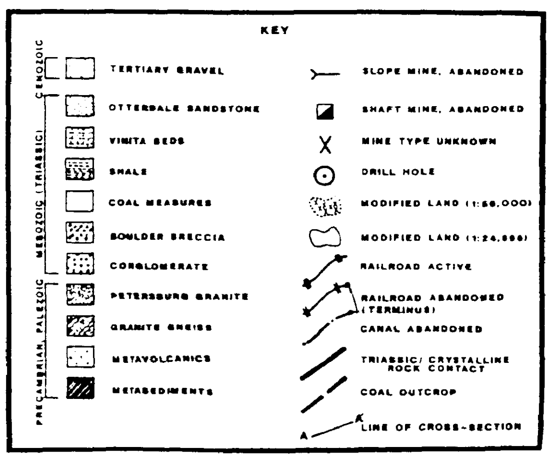
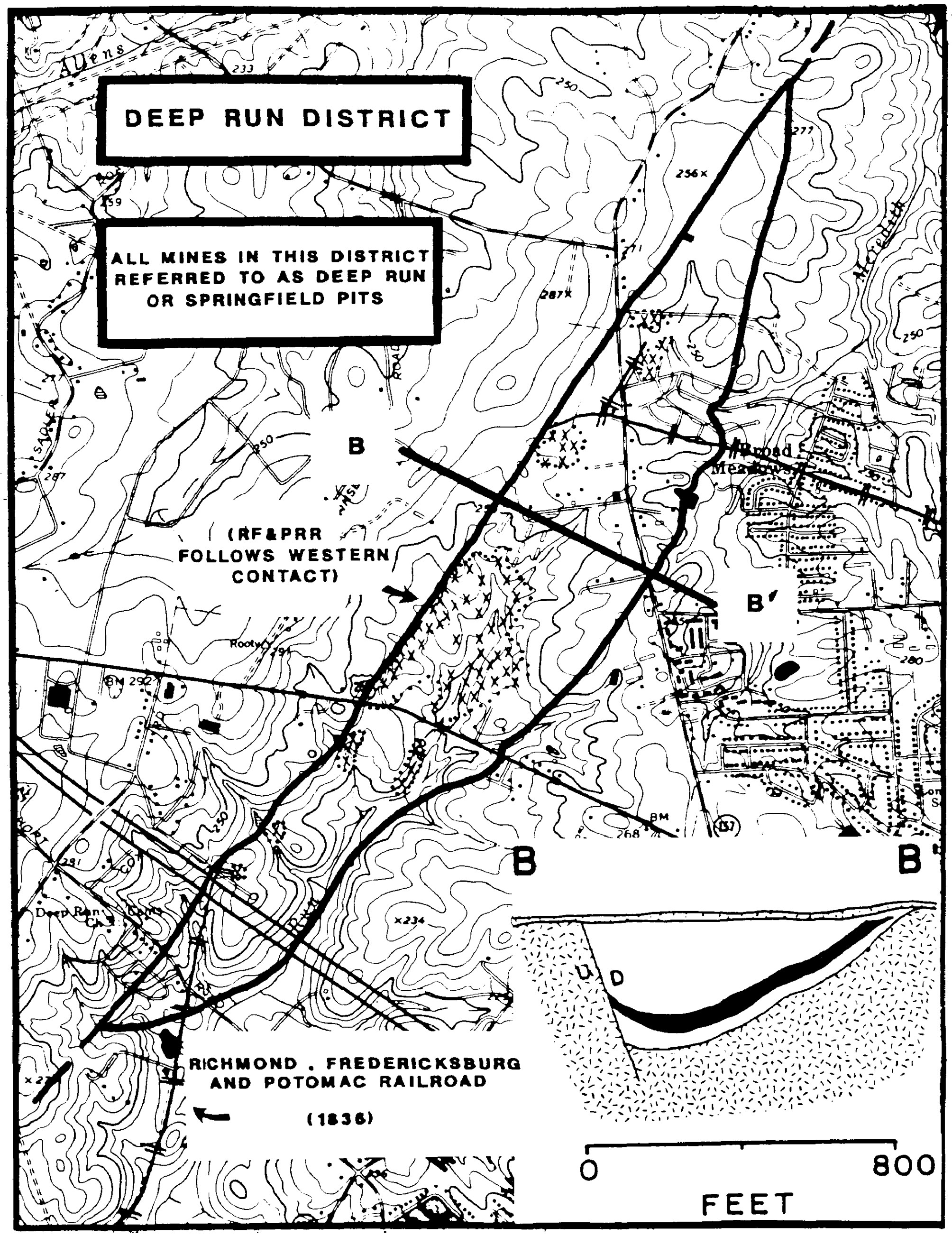


Figure 19



Map of the Deep Run mining district (After Wilkes 1988).

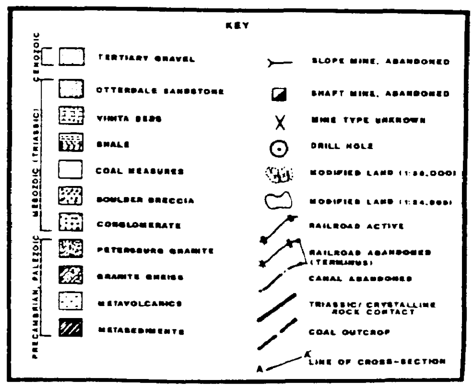
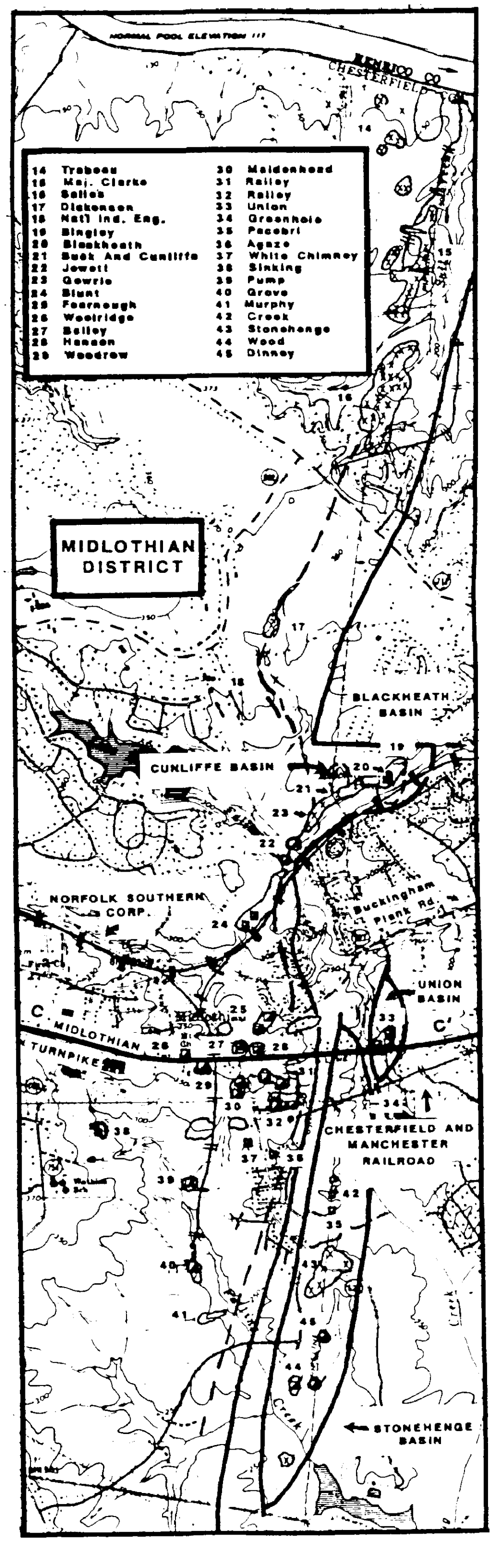
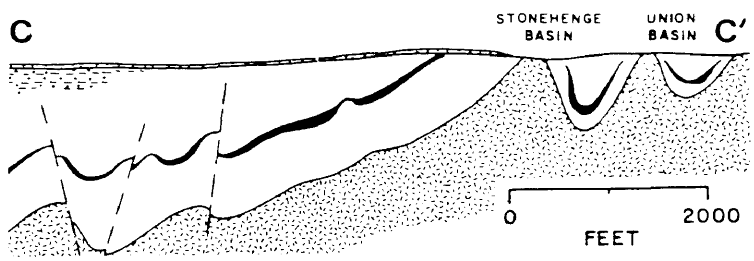


Figure 20



Map of the Midlothian mining district (After Wilkes 1988).



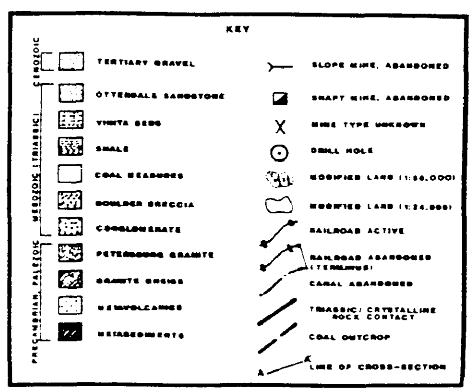
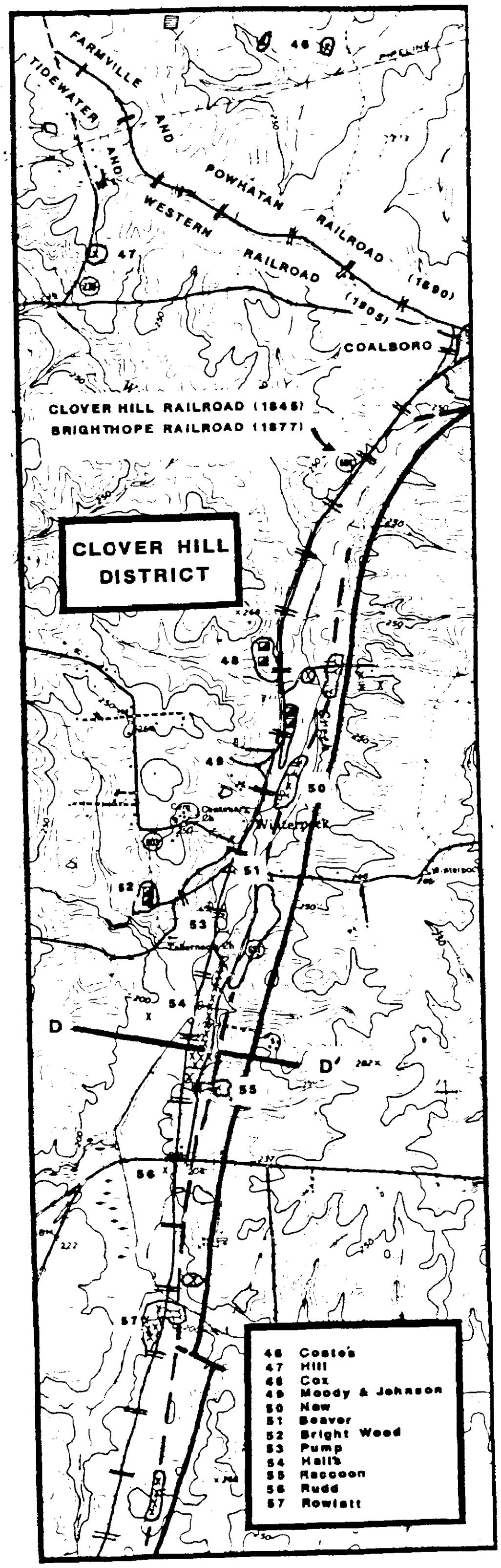


Figure 21



Map of the Clover Hill mining district (After Wilkes 1988).

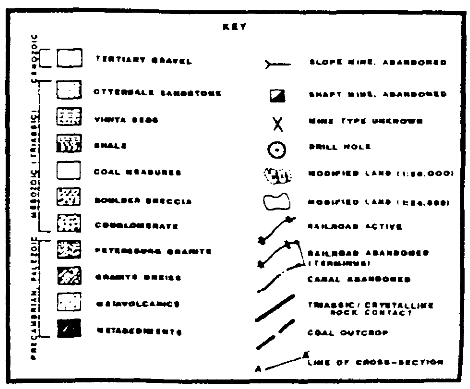
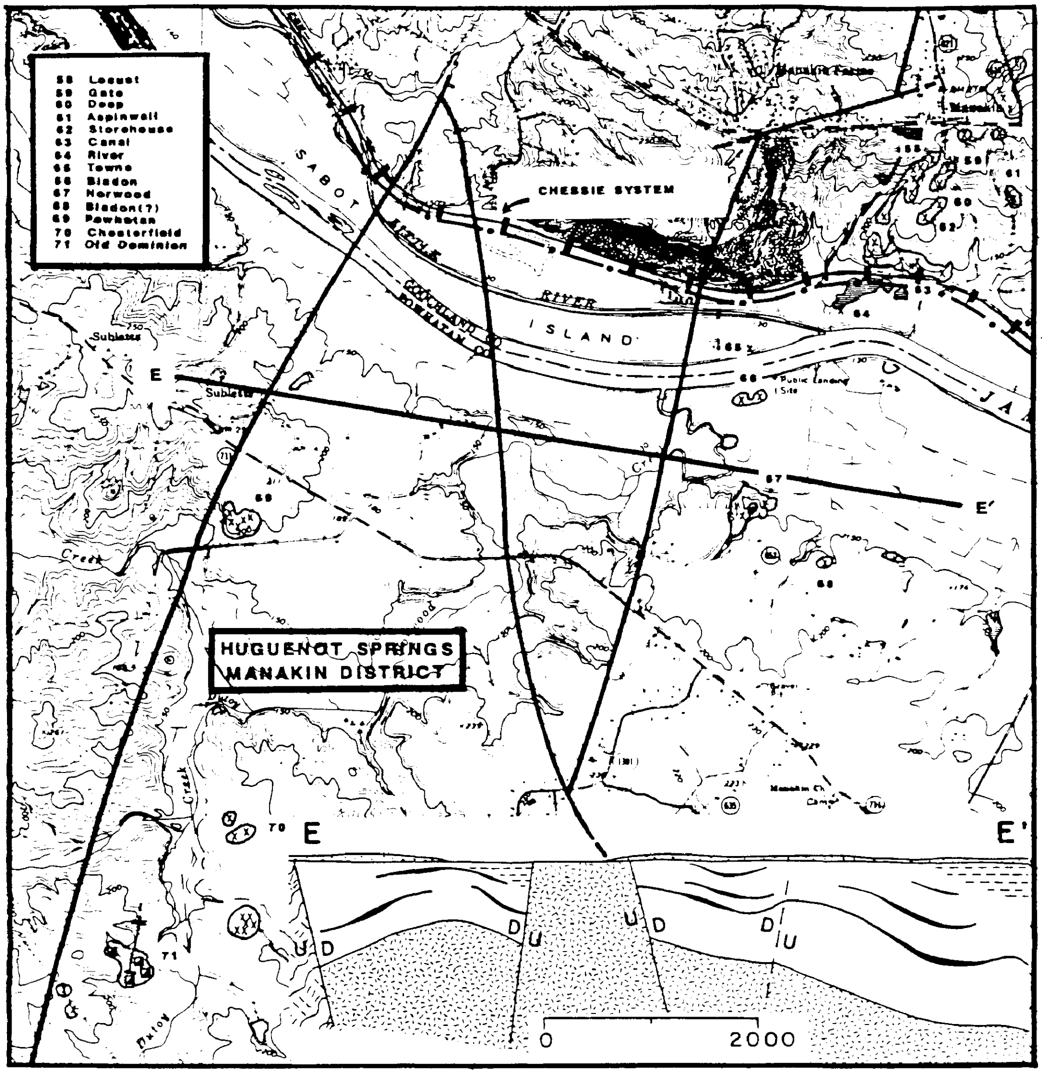
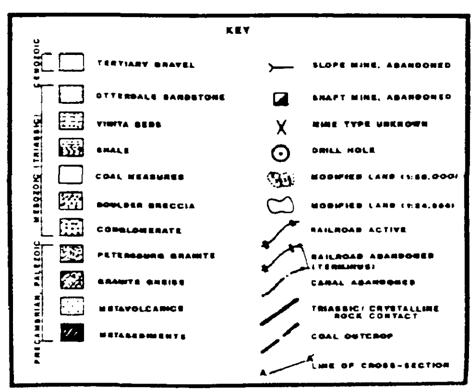


Figure 22



Map of the Huguenot Springs/ Manakin mining district (After Wilkes 1988).



APPENDIX A

RICHMOND BASIN COAL MINING SITES

Detailed Site Descriptions

The following coal mine sites within the Richmond basin have been grouped according to the five designated geologic districts: Carbon Hill, Deep Run, Midlothian, Clover Hill, and Huguenot Springs/Manakin (see Chapter II). Within each district, the individual coal mining sites, whether large collieries or small, shallow pit operations, have been described in as much detail as possible from various historic documents and current research. The dates of operation, owners and operators, number of colliers employed, as well as both archeological and historical information, concerning mining equipment and the structures related to mining activities are included when available. For locations of the individual mine sites see Figures 18, 19, 20, 21, and 22 at the end of Chapter V; for the potential archeological features at each mine site, see Tables 4, 5, and 6 located at the end of this appendix. (Note: ** indicates a mine site not yet field located)

Carbon Hill District

1. **Saunders Shaft** - opened early 1800s, unknown closing date. The site contains a single shaft 220 feet deep (Newell 1888, Shaler and Woodworth 1899, Woolfolk 1901, Robert 1928, Swartout 1930, Wadleigh 1934, Rilee et al 1977, Wilkes 1988). Refer to Table 5 for potential archeological features.

2. **Eureka Shaft** - opened by c1853, unknown closing date. The site contains a single shaft 230 feet deep. A single 50 horsepower steam-powered winding engine was used for water removal (Kimball 1866, Newell 1888, Swartout 1930, Wadleigh 1934,

Rilee et al 1977). Refer to Table 6 for potential archeological features.

3. **Turpius Colliery, Magruder Pit, Maggi Pit** - operated before the Civil War until late the 1880s. The shallow shafts and pits were mined for outcropping coal, which was intended for domestic use (Kimball 1866, Eavenson 1942). Refer to Tables 5 and 6 for potential archeological features.

4. **Gayton Shaft, Coke Shaft, Orchard Shaft, Twin Shaft, Double Shaft, Breaker Shaft** - operated before c1819 and until 1912. The earliest mining occurred in shallow pits. Crouch & Snead sunk the Breaker or Orchard shaft in c1850 to a depth of 180 feet, which were collectively known as the Gayton Shafts. In c1887, the Richmond Coal Mining and Manufacturing Company sunk a shaft 325 feet deep, 40 feet south of the original shaft.

New equipment such as ventilation fans, three 120 horsepower and two 200 horsepower boilers were installed. A three-story breaker building, boiler and engine housing, a machine shop, storage bins, company stores, and stables were constructed at the colliery. There were also brick coking ovens constructed during the late nineteenth century. Housing at "Gayton" village for colliers was also erected by the company. The company ended production in 1912 when an explosion ended mining at this colliery (Newell 1888, Woolfolk 1901, d'Invilliers 1903 & 1904, Treadwell 1928, Roberts 1928, Wadleigh 1934, Jones 1916, Lawton 1942, Rilee et al 1977, Wilkes 1988). This site has subsequently been destroyed by modern development.

5. **Edge Hill Shaft** - opened before c1841, unknown closing date. This shaft was first worked by Richardson in 1841, with approximately 30 hands employed. In 1846 J.C. Deaton and Company worked this shaft with 30 hands. Later, Grabs & Company produced 3,472 tons in 1842 from a single shaft 264 feet deep.

A 35 horsepower engine was used for pumping water and hoisting coal at the pit head. The coal was used principally by blacksmiths and as furnace fuel, and the naturally occurring coke extracted was used in grates and stoves. The Richmond, Fredricksburg and Potomac Railroad provided transportation to market (Wooldridge 1841, Kimball 1866, Newell 1888, Swartout 1930, Wadleigh 1934, Eavenson 1942). Refer to Tables 5 and 6 for potential archeological features.

6. **Barbershop Shaft, Railroad Shaft** - operating dates unknown. The shaft is of unknown depth (Newell 1888, Lemist and Taylor 1921, Rilee et al 1977).

7. **Deep Shaft, Air or Shelter Air Shaft, Snead's Shaft, Crouch & Snead's Shaft, Crouch's Pit, Brooke Shaft** - operated between c1851-c1865; c1873-1875. Snead worked Crouche's property for coal until c1865. The area lay idle until c1873 when the James River Coal Company cleaned out the old workings and obtained naturally coked coal until 1875 (Kimball 1866, Newell 1888, d'Invilliers 1903, Lemist and Taylor 1921, Wadleigh 1934, Rileee et al 1977). Refer to Table 6 for potential archeological features.

8. **Trent Slope, Mule Shaft, Engine Shaft, Carbon Hill Mine, Joseph R. Anderson**

& Company Mine, Coalbrooke Slope, Old Dominion Development Company No.1 Mine - operated between c1848-1944. Partners Crouch and Snead dug a slope mine 1,658 feet, then extended it to 2,400 feet in c1848. The Mule Shaft, 125 feet deep, intersected the main slope for ventilation and water removal. 1851, the Engine Shaft was used in the same manner for the Old Dominion Development Company No.1 Mine. The Engine Shaft was used by Anderson and Company as their main entrance during the Civil War. The coal extracted during the Civil War went to the Tredegar Iron Foundry to produce armaments for the Confederacy. In 1903, all the coal above 1,000 feet had been mined out. At this time the area was known as "Coalbrooke." The Old Dominion Development Company purchased the property and attempted to revitalize the mines with fresh equipment, a new miners village was also constructed. A railroad line from the Chesapeake and Ohio Railroad at Gayton Junction to the village of Gayton facilitated transportation of coals. However, explosions in 1909, 1911, and 1912 killed dozens of miners and eventually lead to the closing of the mines. There were several unsuccessful attempts to reopen these shafts, with the final one made in 1944 (Russell 1892, Daddow and Bannon 1866, Kimball 1866, Daddow 1875, Newell 1888, Woolfolk 1901, d'Invilliers 1903, Loeber 1927, Swartout 1930, Wadleigh 1934, Eavenson 1942, Rilee et al 1977, Wilkes 1988). Refer to Tables 5 and 6 for potential archeological features.

9. **Cottrell's Pits** - operated before c1835 and were abandoned sometime after 1846. William Cottrell owned and operated these pits. In 1846, he employed some 30 hands and extracted between 4 to 500 bushels per day (Wooldridge 1841, Kimball 1866,

Eavenson 1942). Refer to Table 5 for potential archeological features.

10. **Woodwards Pits, Lucy White Tract Pits** (44GO256) - operated between c1762-1911. John Woodward had acquired the 350 acre tract by 1762 (Goochland County DB6:237; DB8:101; DB8:279). Between 1762 and c1825, coal had been mined from shallow pits for domestic consumption, possibly just for the Woodward family.

In 1825, Lancelot Woodward, John Woodward's grandson, assumed control of the mines. At the time of his father Samuel Woodward's death in 1827, Lancelot was indebted to him for an undisclosed amount. Lancelot was forced to relinquish his shares in the coal pits to his mother Elizabeth and his five brothers and sisters. Included in this transfer were "coal pits and slaves employed to work them...6 mules, 1 horse and saddle, 3 wagons, 2 carts and gear, 2 coal machines with ropes, buckets and covers, 25 picks, 8 shovel, 4 mauls, 2 boats with tent cloths and furniture and a parcel of blacksmithing tools and carpenter tools" (Goochland County DB28:195). Lancelot's brother Charles eventually bought the share outright and sold them to Edwin and Virginia Powell (Goochland County DB28:195; DB29:3; DB30:327).

In 1835, Lucy M. Woodward followed her father Samuels interest in the coal pits when she bought the rights the 350 acre tract from her brothers, sister, and the Powells (Goochland County DB30:327;351). In 1835, Lucy Woodward sold one-third of the mineral rights to William Scott (Goochland County DB31:213). Intensive coal mining took place under Lucy Woodward and Scott. In 1840 the assessed value of the land rose sharply from $15 to $72.71 per acre. There were $200 worth of improvements to the property and the tax books list it as "coal land." During this time, they had begun using more mechanized mining methods, equipment, and probably additional wooden frame shelters for the equipment. This is reflected in the increased land values. However, by 1841 the Woodward Pits were listed as lying "unwrought" (Wooldridge 1841:1-14).

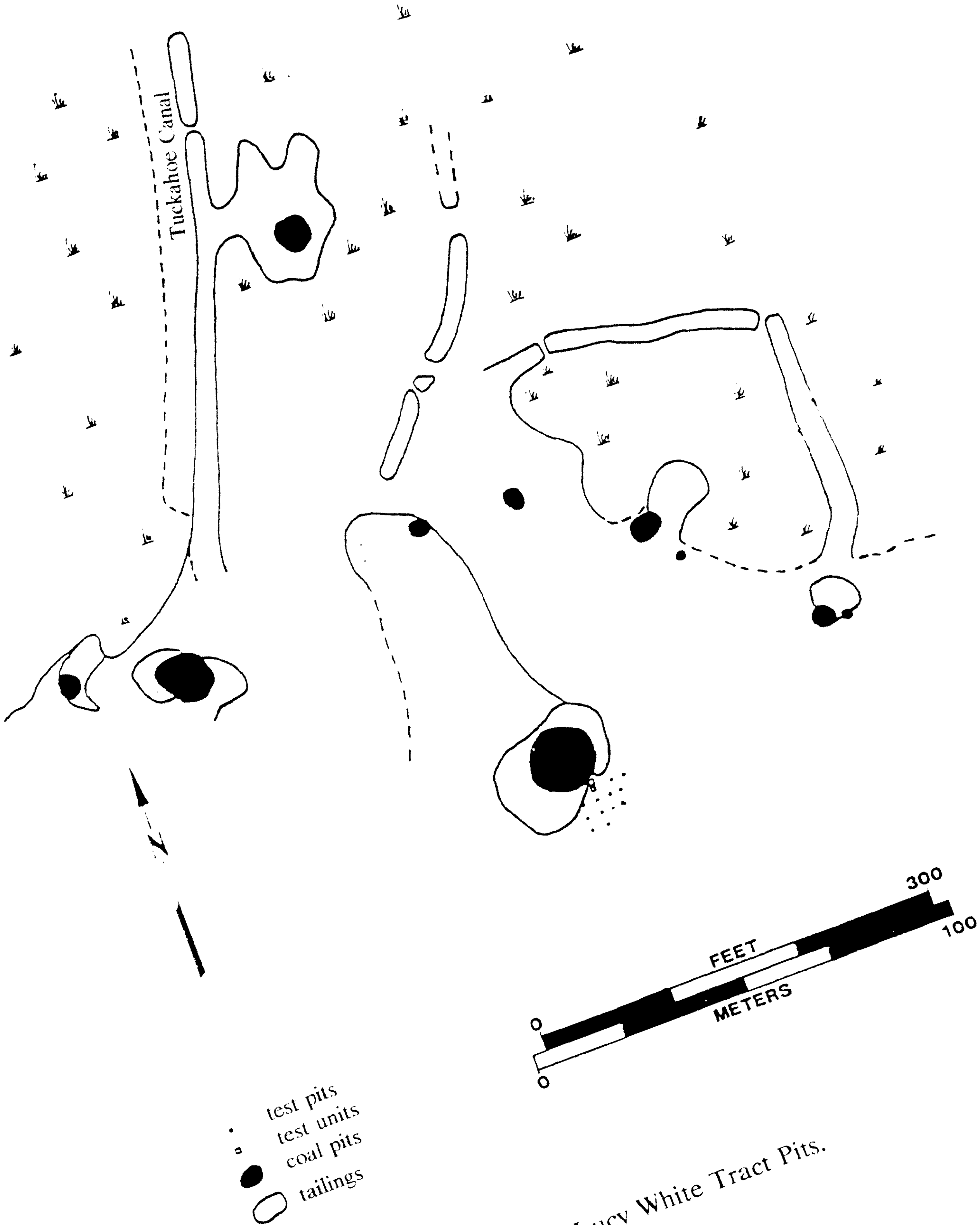
In 1845, Lucy sold the 350 acres back to Lancelot Woodward (Goochland County DB34:260). Upon his death in 1847, "Woodward's coal pits" (as depicted on two 1825? maps of Tuckahoe Creek area: Virginia State Library) were turned over to his executor William A. Deitrick for payment of debts (Goochland County DB34:606). Deitrick maintained the parcel and willed it to Lucy White in 1879 (Goochland County DB44:223). In 1911, at Lucy White's death, the tract returned to Deitrick's heirs (Goochland County DB65:241).

This area was investigated during the Virginia Department of Transportation Route 288 study. A Virginia state archeological site number, 44GO256, was assigned in 1987. The archeological evaluation of this site included systematic excavation of shovel test units, as well as two larger test excavation units one 3 feet square and another 2 feet square (Figure 23). A relatively small area near the largest pit was tested because of the high potential for subsurface features was indicated by a 4 by 10 feet rectangular depression at the pit's edge. The two test excavation units were placed on the depression. Subsequent excavation revealed a deposit of coal dust that had covered the natural ground surface on one side of the depression. This unsalable dust and small broken chunks of coal hoisted to the surface was most likely discarded after being roughly hand sorted at the pit head. A small wooden frame structure may have been located on this depression to provide shelter for pit head activities, such as hoisting and unloading coal baskets. This hypothesis was upheld by the archeological assemblage recovered during excavation of the two test units. The artifacts included brick, nails, spikes, and fragments of banded polychrome pearlware, lustreware, and olive green bottle glass dating no earlier than the 1790s.

Eleven shovel test units were utilized to determine the extent of the possible subsurface feature. Artifacts recovered from these consisted almost exclusively of bricks, nails, and spikes. These artifacts, along with those recovered from the test excavation units, could have been utilized either in the construction of this small shelter and/or in the shoring of the mine shaft with brick or timbers.

This site contained visible evidence of other various coal mining features, such as raised earthen berms connecting individual coal pits, coal pits of varying depth and diameter and their associated overburden piles, possible mine ventilation shafts, as well as transportation features. The sites proximity to Tuckahoe Creek was fortuitous as the creek had been dredged in the 1820s and 1830s to improve passage for the coal bateaux. There also appears to have been alterations to the landscape to facilitate the loading of coal into the bateaux (see Figure 23). The character of Tuckahoe Creek was further alter by the construction of the Tuckahoe and James River Railroad bed (44HE665) in 1840. This transportation improvement adversely affected the Woodward property adjacent to the creek, which is low and subject to flooding. This flooding of the lower portions of the mining area apparently forced the opening of the more extensive pits further up the slope.

Figure 23



44GO256 Woodward's Pits; Lucy White Tract Pits.

The area of both Woodwards Pits and the later Lucy White Tract Pits graphically depicted the change from surface coal mining techniques for domestic use to more intensive exploitation of the mineral. The smaller, shallow pits scattered across the site are indictive of the earlier small scale domestic mining efforts of the Woodward family. The larger pits, with connecting raised earthen berms and canal access to Tuckahoe Creek indicate the more concerted efforts of Lucy Woodward and William Scott toward higher volume extraction of coal. Fortunately the later coal mining activities were not so extensive as to obliterate the sites of earlier mining. This site represents an important example of early coal mining in Goochland County, at both pre- and post-industrial levels over a broad continuum (Wooldridge 1841, Newell 1888, Eavenson 1942, Hernigle 1987, 1988). Refer to Tables 4, 5, and 6 for potential archeological features.

11. **Tuckahoe Pits, Tuckahoe Shaft** - opened during late 1780s and closed before the Civil War. The first mining at this site was under the supervision of Col. Thomas Randolph, destined to supply his blacksmith shops. Shallow pits in this area were mined periodically after this until the War of 1812. In 1837, Dr. W.T. Scott reopened the pits.

The Tuckahoe Coal Mining Company was then organized, and they purchased the entire tract for $30,000. After sinking the Tuckahoe Shaft 412 feet, presumably without encountering coal, they abandoned the shaft. In 1843, Maj. Snead began working the shaft successfully. Fifty hands were employed during 1846, and they raised 300,000 bushels of coal per year. The coal was considered excellent for iron manufacturing processes. Tredegar and Belle Isle Rolling Mills ordered shipments of the Tuckahoe coal

(Wooldridge 1841, Johnson 1846, Richmond ***Whig and Public Advertiser*** July 15, 1846, Heinrich 1878, Newell 1888, Russell 1892, Roberts 1928, Eavenson 1942). Refer to Tables 4 and 5 for potential archeological features.

12. **Tippecanoe Shaft** - operated between c1841-c1860 by the Tippecanoe Coal Company. Only a small amount of coal was mined. This coal was among several samples from the Richmond Basin analyzed by Professor W.R. Johnson in 1843 for the U.S. Navy Department (Johnson 1844, Kimball 1866, Roberts 1928, Eavenson 1942). Refer to Tables 5 and 6 for potential archeological features.

13. **Wickham or Wigham Pits** - opened and closed before Civil War. Coal was obtained from shallow pits along an outcropping (Newell 1888). Refer to Table 5 for potential archeological features.

** **H.J. Cook Mine** - dates of operation and exact location unknown (Robert 1928, Wadleigh 1934).

** **Jones Pit** - dates of operation and exact location unknown (Russell 1892, Wadleigh 1934).

** **Sycamore Shaft** - abandoned by 1888; exact location unknown. This site contains a single shaft 75 feet deep (Newell 1888).

** **Waterloo Pits** - dates of operation and exact location unknown (Roberts 1928, Wadleigh 1934).

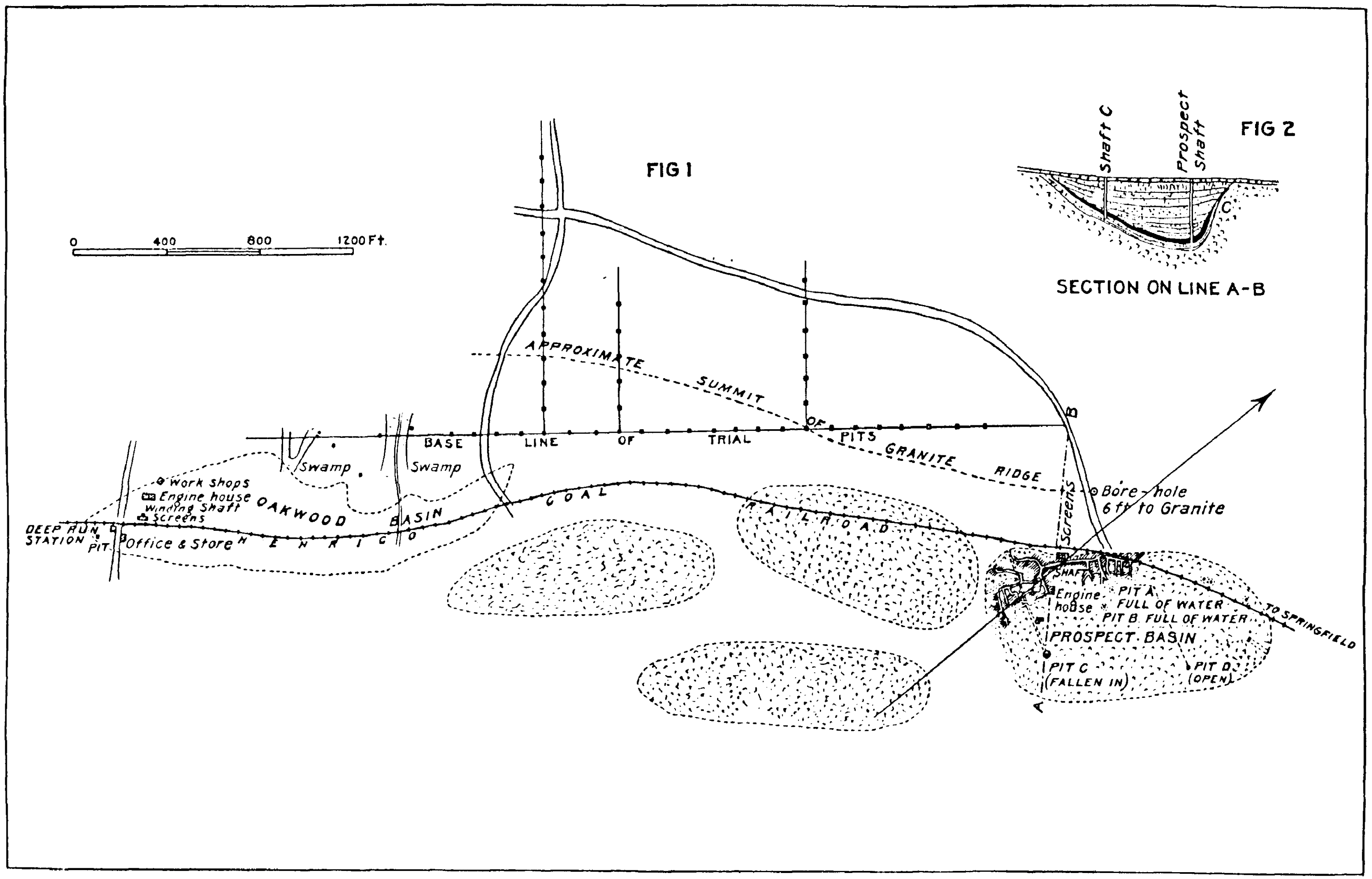
Deep Run District

** **Deep Run Pits, Springfield Pits, Duvall's Pits, Burton's Pits, Ross & Curry Pits, Barr's Pits** - operated between c1761-1924. It is impossible to distinguish between individual pits in this district, and all are generally referred to as the Deep Run pits (Figure 24).

Samuel Duval opened a mine on the Deep Run Road to Richmond in 1760. After Duvals ownership, the mines changed hands several times. On January 1. 1804, Harry Heth and Andrew Nicholson became partners in the coal business, and purchased, among others, the "Deeprun Coalpits in Henrico." By 1804, the pits had flooded and had to be dewatered (Heth Family Papers: J. Nicholson to H. Heth, April 27,1804). It is unclear what occurred to the property after 1804, however, it probably was divided into shares upon the death of Heth.

On December 5, 1815, W.M. Hancock had come into possession of the site and offered the Deep Run Coal Pits for sale in the ***Richmond Enquirer***. The 1,750 acre tract was advertized as containing "the largest body [of coal] in any one tract of Land in this state." Hancock described pits as being ready for work, with "mules, machinery, tools, etc., sufficient to commence immediate operations." There were subsequent owners such as John Barr in 1835, Richardson in 1842, and J.C. Deaton in 1846.

Figure 24



Plan and section of the Deep Run basin (After Clifford;Shaler and Woodworth 1899).

The coal obtained from these mines was transported to the Tuckahoe Canal by cart, was loaded into bateaux and poled to the James River and Kanawha Canal at Lorraine, and finally on to Richmond. The Tuckahoe and James River Railroad later serviced the mines by taking the coal either to the James River Canal (later to the Richmond and Allegheny Railroad) or to the Fredricksburg, Richmond and Potomac Railroad main line near Glen Allen (branch line opened in 1838) (Lyell 1847, Kimball 1866, Rogers 1884a, Wortham 1916,Loeber 1927, Roberts 1928, Swartout 1930, Wadleigh 1934. Eavenson 1942). Refer to Tables 4, 5, and 6 for potential archeological features.

Midlothian District

14. **Trabeau Pits, Burfoot Pits** - operated between c1778-c1841. There were several periods of mining activity, the first occurred between 1778 and 1790, and the second between 1815-1819. The coal and coke mined was advertised as excellent for manufacturing as testified by consumers such as the Bellona Furnace, Union Air Furnace, Crown Factory, a rolling and slitting mill, and the Nail Factory. The coal was obtained from shallow pits and trenches excavated into visible outcroppings. The small coal extracted was popular with the area blacksmiths and brickmakers.

In 1835, the mines were sold to Thomas M. Burfoot and subsequently leased to Standford, Duval and Company. The company sank shallow shafts 50 to 250 feet deep to the south of the old Trabeau pits. Fifty men were employed by the company during this time. The coal was considered unsuitable for another other than domestic fuel.

The close proximity to the James River caused problems with water in the deeper workings. A small steam-powered water pump was used to keep the water from collapsing while being dug (Wooldridge 1841, Shaler and Woodworth 1899, Roberts 1928, Wadleigh 1934, Eavenson 1942, Routon 1949). Refer to Tables 4 and 5 for potential archeological features.

15. **Major Clarke Pits** (44CF318) - opened c1810 and operated until 1832. Maj. John Clarke of Keswick was appointed Superintendent of the Armory by Governor Monroe in 1802, and subsequently dismissed in 1809. After his dismissal, Clarke and William Wirt obtained a contract from the Federal Government to establish a small arms manufacturing business. The Bellona Foundry of Clarke and Wirt was established near Spring Creek, just south of the James River. During the War of 1812, Clarke found a ready market for his armaments.

Coal obtained from pits near by provided the Foundry with necessary fuel. The "Gun Road" provided access to the Manchester Turnpike. The construction of Bellona Arsenal in 1816, provided safe storage for the arms. However, trouble plagued the Bellona Foundry and by 1832 the business was discontinued. Maj. Clark died on May 1, 1844, at which time the land passed to his nephew (Couture 1980:111-115). Apparently, the coal mining was an important but secondary activity on Maj. Clarke's land.

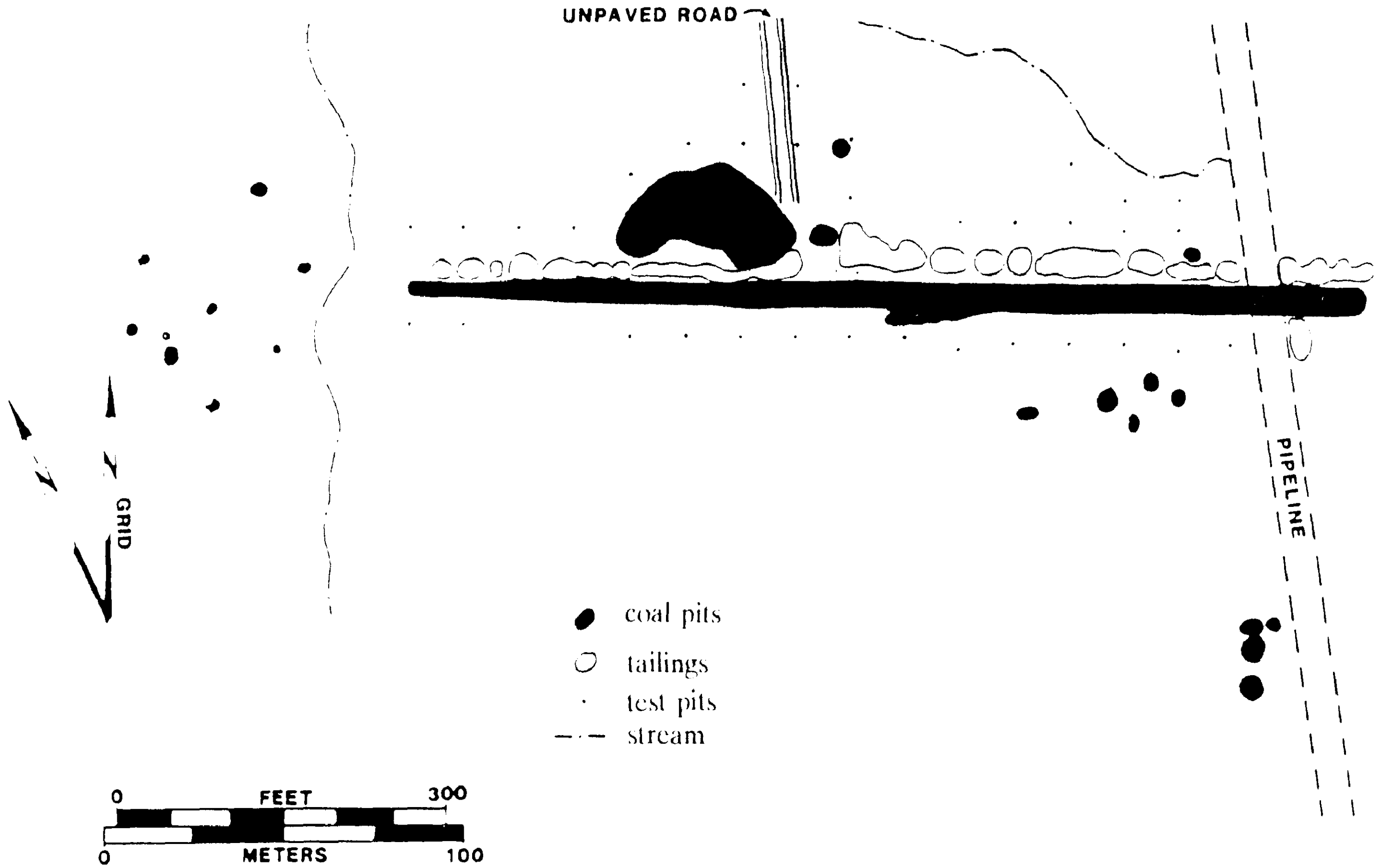
Archeological investigation of site 44CF318 took place in 1986, during the Virginia Department of Transportation's Route 288 study. In the course of this study, systematic shovel test units were excavated and a detailed site map drawn (Figure 25). The most prominent feature associated with Major Clarke's pits is a trench approximately 900 feet long and aligned roughly east-west. The trench is 20 feet wide for the majority of its length, but narrows to 10 feet at its western end. The depth of the trench is approximately 5 to 7 feet. A series of linear earth mounds, averaging 5 feet in height, parallel the north edge of the trench, probably the overburden piles from extracting coal, rock, and soil from the trench.

An old overgrown access road, perpendicular to the center of the trench, leads off to the north toward the James River. The coal and armaments, carried in wagons down the road, could then be loaded in barges for transport to Richmond.

Several clusters of coal pits of varying depth and diameter are also located near the trench. The two largest pits are located slightly west of where the wagon road intersects the trench. These pits are over 70 feet in diameter. Two small clusters of coal pits are located south of the east end of the trench; one is approximately 100 feet south while the other is 300 feet to the south. The last cluster consists of at least nine widely distributed pits 100 to 250 feet west of the western most end of the trench.

Forty-six shovel test units were excavated in a pattern parallel to the trench and resulted in the recovery of no artifacts, although two brick bats were recovered from the surface near the large coal pits. There was no evidence of either the foundry or any structures to house coal mining equipment or miners employed at the pits was located. It is likely that more extensive archeological excavation would reveal structures directly related to both the smelting and mining activities. The workers probably lived in any of

Figure 25



44CF318 Major Clarke's Pits.

several nearby towns such as Coalfield (present day Midlothian, Virginia). (Wooldridge 1841, Wadleigh 1934, Eavenson 1942, Routon 1949, Hernigle 1987, 1988). Refer to Table 5 for potential archeological features.

16. **Salle's Pits** - opened c1730s and closed by c 1841. In 1790, the pits were sold by Col. Heth to Wills, Brown and Company. After this, the pits became the property of the Black Heath Company of Colliers; the pits were sold again in 1839 to the English Company, along with the Maidenhead Pits tract. A rail line from the Black Heath mines passes the Salle pits on the way to the James River (Wooldridge 1841, Shaler and Woodworth 1899, Roberts 1928, Wadleigh 1934, Eavenson 1942, Routon 1949). Refer to Tables 4 and 5 for potential archeological features.

17. **Dickenson Pit** - dates of operation unknown. Coal, between 9 and 12 feet thick, was mined here just below the ground surface. In 1930, the Richmond Syndicate drilled a hole 800 feet west of this pit and encountered coal again at 487 feet deep (Wadleigh 1934).

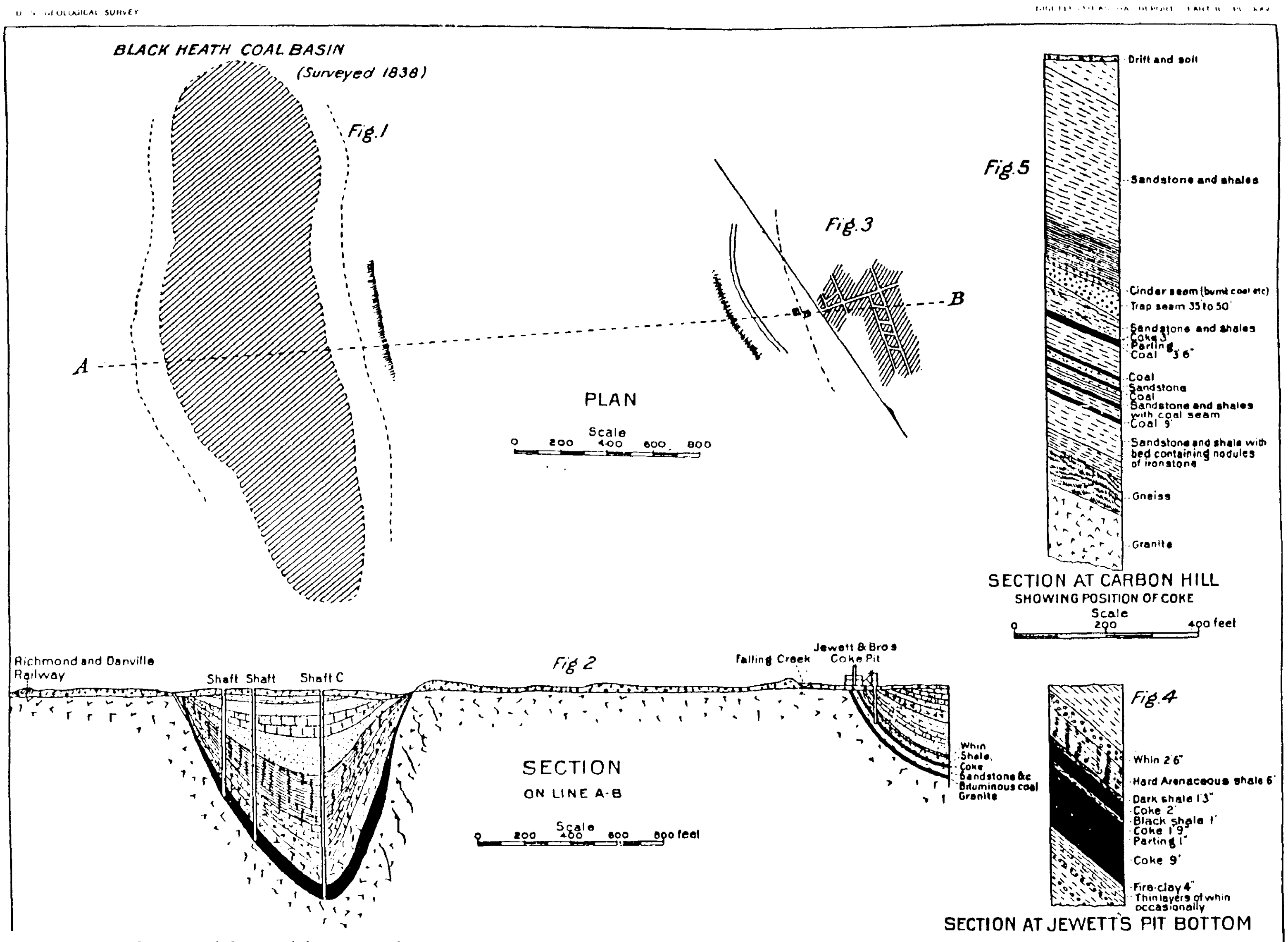
18. **National Industrial Engineers Incorporated Strip** - operated between 1938-c1940. The strip mining of this site included two 50 foot draglines exposing the top of a coal seam reported to be 80 feet thick (Routon 1949).

19. **Bingley Slope** (44CF319) - operated between 1861-1865. The Army of the Confederate States of America worked this slope mine, recovering outcropping coal. They utilized a mule-powered whimgin to raise the coal (Shaler and Woodworth 1899). This site has been destroyed by development in the area.

20. **Black Heath Pits, Chesterfield Mining Company Pits** (44CF319) - opened c1788 and abandoned prior to the Civil War (Figure 26). The Black Heath Colliery was owned and operated by Harry Heth and his family for three decades. The mines became one of the better known and larger coal producers during this period. This fame drew Sir Charles Lyell in 1847 to the Black Heath mines. Lyell provided owners, operators, and miners with stratigraphic profiles as well as rough estimates of the "magnitude and persistency" of the coal strata. Lyell also provided a written record of the interior working at the Black Heath mines after having "descended a shaft 800 feet deep, to find...a chamber more than 40 feet high, caused by the removal of the coal. Timber props of great strength are required to support the roof, and although the use of wood is lavish here as everywhere in the United States, the props are seen to bend under the incumbent weight (Lyell 1847:265).

The Black Heath mines were in operation when technological advances applicable to mining began to occur. Heth erected the first steam-powered hydraulic pump in America, replacing the horse-drawn tubs previously in use. However, for some unknown reason it was never used to haul coal to the surface, only water which filled the lower workings. Heth also attempted to modernize his workings by importing experienced mine

Figure 26



Plan and sections of the old working on the eastern border of the Richmond basin (After Clifford in Shaler and Woodworth 1899).

supervisors, as well as colliers, from England to more efficiently obtain coal. He also wished to make the mining safer for his colliers, to attract both white workers, and slaves. However, despite Heth's best intentions a second explosion ripped through the mines in 1844; this occurred while Heth was visiting English collieries (Taylor 1835, Wooldridge 1841, Daddow and Bannan 1866, Rodgers 1884b, Clifford 1888, Wadleigh 1934, U.S. Bureau of Mines 1934, Eavenson 1942). This colliery has been destroyed by development.

21. **Buck & Cunliffe Pits, Buck Pits, Cunliffe Pits** (44CF319) - operated between c1820s-1842, and again in the early 1880s. These pits are situated within a distinct geologic entity known as the Cunliffe basin, which adjoins the Black Heath Pits. The tract of land totaling 114 acres on which the pits are located, is first referred to in 1790, when John Cunliffe and John McCall purchased the property from John Harris of Powhatan County. This tract became commonly known as "Buck and Cunliffe's Pits." In 1815, the land was divided into quarter interests by Cunliffe. Cunliffe retained one quarter interest for himself, and the remaining three quarters interest was held by Mills, Miller, and Bott (Chesterfield County DB21:264). Sometime in the mid-1830s, John Cunliffe died intestate; subsequently the land was further subdivided by his family. Cunliffe's pits were reportedly exhausted by the 1840s after two decades of use; however, they were listed as being worked again in the early 1800s (U.S. Census 1880 "Mining Directory" 15).

An archeological survey of site 44CF319 occurred during 1986 for the

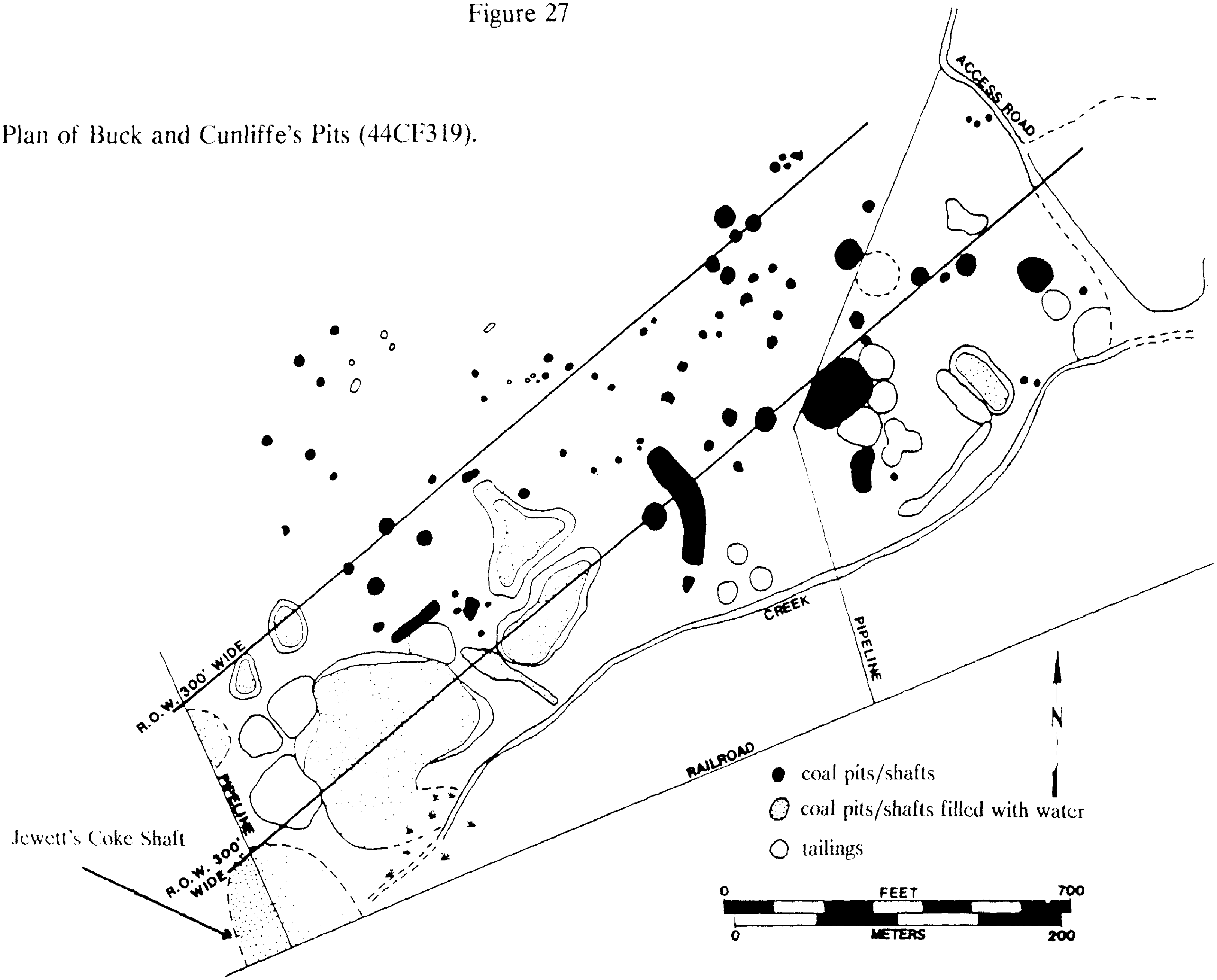
VirginiaDepartment of Transportation's Route 288 study. A detailed map of the site was drawn showing the numerous shallow pits (presumed to be earlier) and several larger pits and probably shafts filled with water (presumed to be later) (Wooldridge 1841, Wadleigh 1934, Eavenson 1942, Hernigle 1987, 1988). These pits are in danger of being destroyed by encroaching development from the north (Figure 27). Refer to Tables 5 and 6 for potential archeological features.

22. **Jewett Coke Shaft** (44CF319) - opened in c1882 and in business at least until 1899. A single shaft extended to a depth of 137 feet to the "Coke seam." The natural coked coal encountered in this shaft was particularly valuable commodity, enabling iron foundries around Richmond to bypass the expense and time involved in distilling coke from coal.

This large shaft was located during the Route 288 survey (Opperman et al 1987; Traver et al 1988). It is included in the Virginia site designation number 44CF319 (see Figure 27). According to a profile map of the area surrounding Jewett's Coke Pit, there were structures over and near the shaft (see Figure 26) However, no structures or equipment was visible during the survey, and no archeological test units were excavated because of the extremely high water level. (Clifford 1888, Shaler and Woodworth 1899, Roberts 1928, Wadleigh 1934, Eavenson 1942, Hernigle 1987, 1988). Refer to Tables 5 an 6 for potential archeological features.

Figure 27

Partial Plan of Buck and Cunliffe's Pits (44CF319).



23. **Gowrie Shafts** (44CF319) - operated between c1821-c1841. These two shafts were owned by Murchie, Mosely, and Brander and leased by George E. Swann in 1821. One shaft reached a depth of 160 feet and the other 460 feet. Up to 40 men were employed to work and they could produced 111 tons daily. The coal extracted was deemed suitable for grate use and steam engines. Structural problems in 1841 forced the abandonment of the shafts (Wooldridge 1841, Taylor 1855, Roberts 1928, Wadleigh 1934, Eavenson 1942, Routon 1949). Refer to Table 6 for potential archeological features.

24. **Blunt Shaft, Thompson Shaft, Wills Shaft, Willis & Michaels Shaft, Aetna Shaft, Etna Shaft** - see Chapter V. (Taylor 1835 & 1855, Rogers 1884b, Clifford 1888, Eavenson 1942, Routon 1949, Hernigle 1987, 1988).

25. **Fearnought Shaft** - dates of operation unknown. Located south of the Etna Shafts on the south side of Southern Railway System tracks (Shaler and Woodworth 1899).

26. **Ellyson's Pits, Wooldridge Pits, Old Midlothian Pits, Road Shaft** - opened before 1765, when coal from Ellyson's pits was being advertised in the New York Mercury (July 22, 1765), and closed by c1838. This may be the first instance of commercially mined coal, instead of for primarily local domestic needs. In 1806 and 1807 land owned by Wooldridge, Ellyson, and others was surveyed by William LaPrade as part of the road Martin Railey was building from Falling Creek to the Midlothian turnpike. This road would have serviced the pits, enabling wagons and carts access to

the pits. These pits were listed as being near Falling Creek in the April 20, and August 10, 1810 issues of the ***Richmond Enquirer***. Ellysons involvement is not mentioned again after 1810, and it is likely that Wooldridge purchased his pits.

Wooldridge's mine was the deepest near Falling Creek and the only one with a steam engine to raise coal and water. The other pits clustered around Falling Creek used mules and windlasses. The coal was mined by slaves and transported on the Chesterfield and Manchester Railroad (Martin 1835:152). The mine supposedly produced 760,000 bushels in 1835, but only 70,000 bushels in 1837 (U.S. Congress "Memorial of Virginia Coal Mine Proprietors" House Doc. 93:2-3,5). Wooldridges (old) pit was listed as not worked in 1837, but other shafts were being sunk in the same area. In 1838, the following equipment was listed for sale at the Wooldridge property on Falling Creek: "one 30 horsepower Pumping and Winding Engine, with extra parts, flat ropes, tools, and fixtures thereto attached;-also the Buildings, Railroad, Bogies, Cranes, Corves, Slate Car, etc,... at the Mid-Lothian Pits" (Richmond Enquirer Feb. 1, 1838). Wooldridges old pit was also known as the Road Pits. (LaPrade 1806 and 1807, Wooldridge 1841, Cox and Henrich 1888, Roberts 1928, Wadleigh 1934, Eavenson 1942, Routon 1949, Ritz 1975)

27. **Bailey Pits** - operated between c1800s-c1860. A small mine (Wooldridge 1841, Wadleigh 1934). Refer to Tables 5 and 6 for potential archeological features.

28. **Hanson Shafts** - opened early 1800s, unknown closing date. The site was operated by the English Company (LaPrade 1900). Refer to Table 5 for potential

archeological features.

29. **Woodrow Pit** - opened before 1900?, unknown closing date. The pit is located on the Manders tract (LaPrade).

30. **Maidenhead Pits, English Company Pits, Heath Pits** - opened c1821 by the Black Heath Company of Colliers. The site contained several shafts varying from 150 to 700 feet deep. The coal was transported by wagon along the Midlothian Turnpike to Manchester for sale.

In 1839, Col. John Heth purchased these mines at the same time he bought the Salle Pits as well as an undetermined adjoining tract. During 1841, Heth traveled to England to gain foreign capital for investment in these mines; at this time an explosion in the Maidenhead Pits killed 53 of 56 men within the mine. The shaft were the explosion occurred was 700 feet deep, and a second was 600 feet deep. Men from Newcastle were employed as "ventilators" to prevent gas-related explosions. According to A.S. Wooldridge, the Maidenhead tract contained in 1841, "...all the buildings, engines, and other machinery necessary for a large business, with a railroad, leading from the pits to the James...." These mines were capable of producing 30,769 tons of coal per year (Wooldridge 1841, Cox and Heinrich 1888, Roberts 1928, Wadleigh 1934, Eavenson 1942, Routon 1949, Ritz 1975). Refer to Table 5 for potential archeological features.

31. **Railey Pits, Mills Pits, Mills, Reid and Company Pits, Mills Creek Pit, Mills**

& Reid Creek Pit - opened in the late 1700s and closed by c1841. In 1811, the mines and property of Nicholas Mills were leased to Harry Heth. The coal mined here was transported by wagon on the Midlothian Turnpike.

In 1829, Mills and Beverly Randolph obtained a charter enabling them to build a railroad from the mine to docks in Manchester on the James River. Cladius Crozet designed the Chesterfield and Manchester railroad and Moncure Robinson supervised construction. The railroad, completed in 1831, had wooden rails topped with iron straps. It utilized gravity with a 13 mile stretch downhill to the river. When the loaded cars approached the river, a block and tackle system was attached to empty cars at the docks, the empty cars were then pulled uphill by the weight of the loaded cars. Mules riding in the last car pulled the empty cars back to the mines. Transportation costs dropped considerably for the distance between the mines and the Manchester docks, from 10 cents to 3 cents a bushel (Wooldridge 1841, Chesterfield County DB 9:7-10, DB 7:540, Schmitz 1895, Roberts 1928, Wadleigh 1934, Eavenson 1942, Routon 1949, Claflin 1978). Refer to Tables 4 and 5 for potential archeological features.

32. **Bell Shaft** - opened before c1823 and abandoned by c1923. This shaft was located on the Railey Hill tract, owned by Nicholas Mills. The shaft reached a depth of 400 feet, which caught fire in 1823. A fire damp explosion in 1833 caused fires to burn until after 1848, when the fire spread to the Rise Shaft. Chesterfield Coal and Iron Manufacturing Company was the last operator of this shaft (Taylor 1835, Heinrich 1873, Schmitz 1895, Roberts 1928, Wadleigh 1934, Routon 1949, Claflin 1978). Refer to Tables 5 and 6 for

potential archeological features.

33. **Union Pits** - operated c1824-c1839. These are listed as being among the oldest mines in the Richmond basin, and known for producing excellent quality coal. These pits were reopened in 1880 by Jacob Beach. These are the only mines within the Union Basin (Wooldridge 1841, Shaler and Woodworth 1899, Roberts 1928, Wadleigh 1934, Eavenson 1942, Routon 1949). Refer to Tables 5 and 6 for potential archeological features.

34. **Greenhole Shaft** - operated between c1790 and exhausted before c1841. Nicholas Mills owned the shaft in 1837, and by 1840 there was a 100 foot shaft. By 1841, the mine was owned by the Midlothian Company but had been worked out (Rogers 1884b, Clifford 1888, LaPrade 1900, Roberts 1928, Wadleigh 1934, Eavenson 1942, Routon 1949). Refer to Tables 4 and 5 for potential archeological features.

35. **Pacebri Pit** - opened before 1840, unknown closing date. This shaft was operated by the Creek Company (Wilkes 1988). Refer to Table 5 for potential archeological features.

36. **Agaze Shaft** - opened in 1873, unknown closing date. This 400 foot shaft was operated by the Creek Company (Heinrich 1873, Schmitz 1895). Refer to Table 6 for potential archeological features.

37. **White Chimney Shaft, Old Midlothian Pit** - operated between 1800s-1856; 1858-1861. The Midlothian Coal Mining and Manufacturing Company sunk this shaft in the early 1800s to a depth of at least 360 feet. By 1856, the workings must have filled with water because they attempted to clear the mine but water in the old workings broke through, drowning men. In 1858, a 500 horsepower engine was brought in to pump water out; this allowed mining to continue until a fire in 1861 (Lyell 1847, Heinrich 1876, Schmitz 1895). Refer to Tables 5 and 6 for potential archeological features.

38. **Sinking Shaft** - operated between c1865-1869. Col. George Wooldridge, in charge of the Midlothian Coal Mining and Manufacturing Company, borrowed $180,000 from Mr. Burrows of Albion, New York to sink this shaft. The company encountered no coal after excavating 1,022 feet and drilling an additional 317 feet. This shaft caused the Midlothian Coal Mining and Manufacturing Company to be sold at public auction in 1869. A final unsuccessful attempt to obtain coal was made in 1874 (Russel 1892, Schmitz 1895, Shaler and Woodworth 1899, Woodworth 1902, d'Invilliers 1904, Jones 1916, Wadleigh 1934). Refer to Table 6 for potential archeological features.

39. **Pump Shaft, Midlothian Shaft, Middle Shaft** - operated between c1836-1869. The Pump Shaft is one of four shafts sunk by the Midlothian Coal Mining and Manufacturing Company, the others are the Grove, Middle, and Woods Shafts. During the sinking of the shaft, a mule driven windlass was used to haul out the overburden. The shaft was 11 feet square, shored by timbers and divided into 4 sections for haulage

and ventilation. Ventilation within the mine was accomplished using wooden brattice in the center of the main gangways to separate incoming and outgoing air. A furnace was placed at the base of the upcast shaft for additional air circulation. The Pump Shaft was excavated to a depth of over 722 feet, where a coal seam 36 feet thick was located in 1839. The company's efforts were then concentrated on this shaft.

The coal mined was moved from the working face to the pit bottom by mules and hoisted to the surface by a mule-windlass located at the pit head. Later a steam engine was installed at the pit bottom to move coal from the working face to the pit bottom, and a second installed at the pit head to hoist coal and water from the mine. A surface railway was used to move the baskets, or corves, to the screening area. After being screened, the coal was hand-loaded into railroad cars. In 1840 3,000 bushels of coal were raised by 150 men and 25 mules.

In 1867, the Midlothian Coal Mining and Manufacturing Company failed due to their futile efforts at the Sinking Shaft, and were sold at public auction in 1869. A total of two million tons of coal were produced from this mine between 1839 and 1867 (Lyell 1847, Cox and Heinrich 1888, Schmitz 1895, d'Invilliers 1904, Roberts 1928, Wadleigh 1934, Routon 1949). Refer to Tables 5 and 6 for potential archeological features.

40 & 41. **Grove Shaft, Murphy Slope** - operated between c1836-late 1880s; 1902-1904; 1920-late 1920s. The Grove Shaft was sunk to a depth of approximately 622 feet, with work on this shaft coinciding with mining at the Pump, Middle, and Woods shafts. After work slacked at the Pump Shaft, additional slopes were dug off the main Grove

Shaft. In 1869, following the failure of the Midlothian Coal Mining and Manufacturing Company, Mr. Burrows of Albion, New York bought the Midlothian tract, along with all company owned equipment and buildings, such as the Wooldridge Company Store. Copper and brass tokens of this period were given as payment for mining services. Tokens in denominations of 5, 10, 15, 25, 100, were stamped with "W.R. Burrows, Agt./Will Pay In Goods/1/Ct. At Midlothian Store" (Schenkman 1980:117). These types of tokens replaced money at the larger mining company stores in the Richmond basin. Burrows also would have taken possession of the "Hospital" building that the Wooldridges constructed in the mid-nineteenth century. Later, under Burrow's ownership, the "Church at the Pits" was built for the black colliers.

In 1871, O.J. Heinrich, a prominent English mining engineer, was also placed in charge of the mining. In 1873, Heinrich had the Grove Shaft cleared out and two rock tunnels were excavated westward from the old slope into the coal seam. A small ventilation shaft was sunk south of the main shaft, and entered the upcast shaft. Like the Pump Shaft, this shaft was also 11 feet square, and divided in half by timbers. The north side was used as the upcast shaft, utilizing the draft created by a boiler at the shaft bottom. The boiler also served as the blacksmith's shop. Later, a Guibal fan, powered by a steam engine, was installed to create ventilation. The southern half of the main shaft was further divided in two for hoisting and downcast. The 4 feet square hoisting cages were powered by a mule hoist. A direct-acting engine, driven by a double drum was used for hoisting.

After a methane gas explosion in 1876, O.J. Heinrich was fired and Mr. Dodd placed in charge of the Grove Shaft operations. A second methane explosion in 1882 was caused by a roof fall that broke the central brattice, disrupted ventilation, and allowed methane to accumulate. This explosion caught the workings on fire and the mine had to be sealed off. During the fall of 1883, efforts were focused on cleaning up the mine after the explosion.

In the late 1880s, Burrows died and his property lay idle until 1894 when it was purchased by a Pennsylvania company. This company attempted to mine the area east of the Grove shaft, as well as clean out the Grove Shaft, but this was too expensive a venture.

In 1902, the Richmond Syndicate bought the Midlothian tract and reopened the Grove Shaft, in addition to a double track slope 900 feet south of the Grove Shaft. Meriwether Jones, a mining engineer, was in charge. He situated the new slope so that it connected with an old updip slope within the Grove Shaft workings and used it for hoisting and downcast ventilation. The Grove Shaft was used for an escapeway and as upcast ventilation. By 1904 all the commercially minable coal had been removed and the mines closed.

The Murphy Coal Corporation purchased the property in 1920. The previous company's improvements were utilized and more modern machinery was brought in; this included two 250 horsepower boilers, high volume water pumps, new incline rails, numerous 1 ton cars, a 200 feet long tipple, a large bin, engine and winding houses, and an office building. The Grove Shaft served as an emergency exit and had a large steam pump and hoisting machine located at the pit head. These operations ceased sometime before 1925, but the pumps kept the mines water-free until they were shut down in the late 1920s (Heinrich 1876, Cox and Heinrich 1888, Schmitz 1895, Shaler and Woodworth 1899, d'Invilliers 1904, Jones 1916, Roberts 1928, Tredwell 1928, Wadleigh 1934). Refer to Tables 5 and 6 for potential archeological features.

42. **Creek Company Pits** - operated between c1837-late 1840s. The Creek Company operated these mines, employing approximately 70 men. Between 1839 and 1840, 250,000 to 300,000 bushels of coal were extracted. By 1841, only one shaft 380 feet deep was being worked. Mules hauled coal from the working face to the pit bottom, which was then hoisted to the pit head by a steam engine. The company owned "all the necessary machinery, mules, and about 30 men, with a sufficient outfit of houses, two coking ovens, and a branch railroad connecting their mines with the main coal railroad (Chesterfield Railroad) to Manchester" (Wooldridge 1841, Kimball 1866, Cox and Heinrich 1888, Robert 1928, Wadleigh 1934, Eavenson 1942, Routon 1949, Ritz 1975). Refer to Table 5 for potential archeological features.

43. **Stonehenge Pits** - operated between 1796-1832; 1848-1896. This property was owned by Martin Railey, and his heirs, and contained numerous shafts of various depths ranging between 50 to 400 feet deep. The coal was purchased as grate and locomotive fuel in the 1800s. The mines closed in 1832. In 1838, the ***Richmond Enquirer*** (Feb. 1, 1838) advertised for sale by the Wooldridge family "one 8 horsepower Winding Engine complete, and the Buildings, Railroads, etc., at the Stone Henge Pits." John J. Werth and

Company reopened the mines in 1848 and produced coal until 1896 (Roberts 1928, Wadleigh 1934, Eavenson 1942, Routon 1949, Ritz 1975). Refer to Tables 5 and 6 for potential archeological features.

44. **Woods Shaft** - operated between c1836-c1876. This shaft (one of four opened by the Mining and Manufacturing Company) was sunk to a depth of 625 feet (LaPrade 1900,Roberts 1928, Wadleigh 1934). Refer to Tables 5 and 6 for potential archeological features.

45. **Dinny Pit** - opened before c1900, probably worked into early 1900s. A small mine located on the F.C. Dinny/McTyre tract in 1900 (LaPrade 1900, Wilkes 1988). Refer to Table 6 for potential archeological features.

** **Bellona Arsenal Shafts** - dates of operation and exact location unknown. These are probably located near Maj. Clarke's Pits, (or could be identical to Maj. Clarke's Pits) as the arsenal was constructed just to the west of his Bellona Foundry and associated coal pits (Wadleigh 1934).

** **Bolling (or Boiling) Pit** - operated between 1842-1880; exact location unknown (Shaler and Woodworth 1899). Refer to Tables 5 and 6 for potential archeological features.

** **Diamond Hill Pit** - dates of operation and exact location unknown (Roberts 1928, Wadleigh 1934).

** **Forbes Pit** - dates of operation and exact location unknown (Roberts 1928, Wadleigh 1934, Routon 1949).

** **Garden Wall Pit** - dates of operation and exact location unknown. This may be the Gardenhole Shaft (Brown 1937, Wilkes 1988).

** **Jack Pit Shaft** - dates of operation and exact location unknown. Reported to be located near the Grove Shaft (d'Invilliers 1904).

** **Rise Shaft** - dates of operation and exact location unknown (Schmitz 1895, Wadleigh 1934).

** **Lauree Pits, Laurel Pits** - operated during the late 1830s. The location of this mining site is unknown. They were owned by A.& A. Wooldridge and Company, and were listed for sale in 1838 (***Richmond Enquirer*** Feb.1, 1838; U.S. Congress 24th, 2nd Session: "Memorial of Virginia Coal Mine Proprietors" House Doc. 93, Jan.20, 1837).

Clover Hill District

46. **Coate's Pits** - opened early 1800s, unknown closing date. The mine was operated by Mr. Hall of Petersburg during the early 1800s. This is the northern most mine in the Clover Hill district (Tuomey 1842, LaPrade 1900). Refer to Table 5 for potential archeological features.

47. **Hill's Pits, Hill's Shaft** - opened c1822 and abandoned 1828. This site contained three shafts, with one shaft approximately 400 feet deep (Wooldridge 1841, Tuomey 1842, Daddow and Bannon 1866, Taylor 1835). Refer to Table 5 for potential archeological features.

48. **Cox Pits, Clover Hill Pits** - operated between c1839-late 1800s. Jason H. Cox opened a slope mine into an outcrop on a hillside near Clover Hill. This slope was soon abandoned as it encountered the geologic "Garrett Trouble" formation. In 1840, Mr. Cox organized the Clover Hill Coal Mining and Manufacturing Company and proceeded to dig two 240 feet shafts 336 feet west of the old slope. In 1842, 25 men were employed at the pits.

Coal mined was transported to the pit bottom in carts pulled by mules. Coal and water were hoisted by a small steam engine. Wagons moved the coal from the mine to the Appomattox River at Epps Falls. Coal was loaded into boats for the trip to Petersburg. The Clover Hill Railroad, completed from the Clover Hill mines to the

Appomattox River in 1845, superseding the wagon road. The railroad met with such success that the company began building an 18 mile long railroad to the Richmond and Petersburg Railroad at Chester Station, which was completed in 1847. There may have been man-made coke created here between 1865-1870. This would have been done in an eight-foot square brick oven, and utilized the large quantity of small coal obtained from this mine.

In 1867, an explosion at the Clover Hill Pits closed the mines (Bright Hope, Raccoon, and Hall's Pits) temporarily. A cholera epidemic in 1868 further dampened the mining operations. The Clover Hill Coal Mining and Manufacturing Company, including mines and railroad, was sold by foreclosure to the Bright Hope Mining Company in 1877. Bright Hope continued haulage from the Clover Hill mines and others in the district until the late 1800s (Tuomey 1842, Kimball 1866, ***Richmond Enquirer*** April 5, 1867, Bladon 1883, Cox and Heinrich 1888, Schmitz 1895, Woodworth 1902, d'Invilliers 1904, Jones 1916, Wortham 1916, Roberts 1928, Wadleigh 1934, Eavenson 1942, Ritz 1975, Wilkes 1988). Refer to Tables 5 and 6 for potential archeological features.

49. **Moody and Johnson Pits** - opened before c1840, unknown closing date. This property was owned by Mr. Anderson and leased to Moody and Johnson. Coal was mined from the 100 foot shaft by approximately 15 men in 1842. The coal was transported to Eppes Falls on the Appomattox River by wagon and then on the railroad (Wooldridge 1841, Tuomey 1842, Wadleigh 1934, Eavenson 1942, Ritz 1975). Refer to Table 5 for potential archeological features.

50. **New Slopes** - opened before c1890, unknown closing date. Several slope mines worked (Schmitz 1895). Refer to Table 6 for potential archeological features.

51. **Beaver Slope** - operated in 1877, unknown closing date. This slope mine was part of the Bright Hope Coal Company operations (Schmitz 1895, Wadleigh 1934). Refer to Table 6 for potential archeological features.

52. **Bright Hope Shafts** - operated between 1844 and 1889. These shafts were owned by the Clover Hill Mining Company. For ventilation, boilers were located at the bottom of one shaft. These boilers are believed to have been responsible for the 1859 explosion which killed 17 miners, and the 1873 explosion which killed 69 miners. Later that same year a third explosion left the mine on fire. Water was allowed to fill the workings to stop the fire. The mine was drained in 1880 and worked out when the property was sold to the Farmville and Powhatan Railroad in 1889 (Cox and Heinrich 1888, Schmitz 1895, Roberts 1928, Wadleigh 1934, Eavenson 1942). Refer to Tables 5 and 6 for potential archeological features.

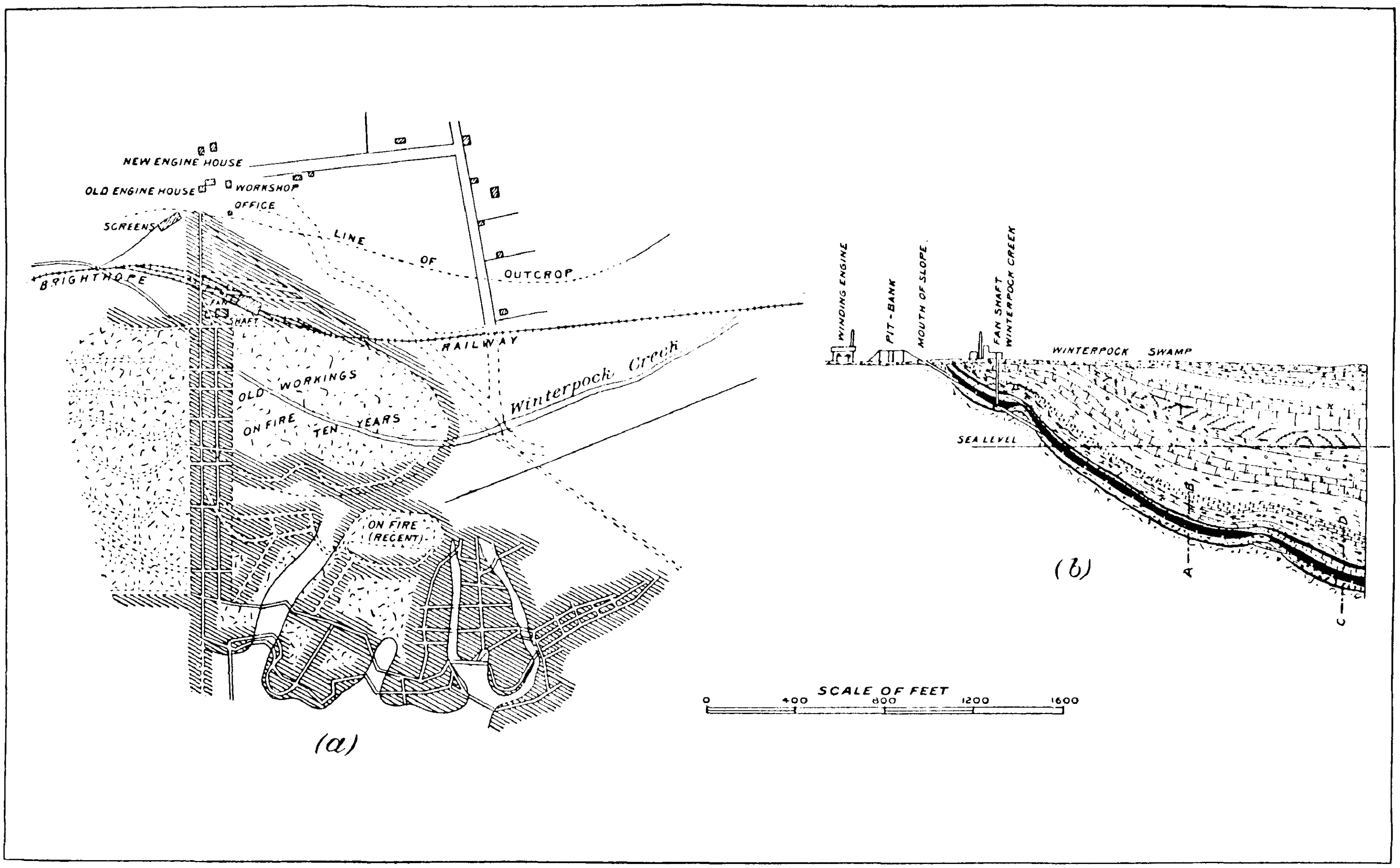
53. **Pump Slope** - opened ?c1877, and closed 1889. This slope was connected to the Bright Hope Shaft workings, probably to drain them (LaPrade 1900, Wadleigh 1934). Refer to Table 6 for potential archeological features.

54. **Halls Retreat Slope, Hall's Pits** - opened by c1867 and closed 1889. This slope, owned by the Clover Hill Coal Mining Company, was probably used as an entry to the Bright Hope mine (LaPrade 1900, Wadleigh 1934, Eavenson 1942). Refer to Table 6 for potential archeological features.

55. **Raccoon Slope** - operated before c1863, and closed 1884. This slope mine experienced two explosions, one in 1863 and a second in 1879, but a royalty dispute closed the mine in 1884. A plan and section map of the Raccoon Coal Mine depicts several structures associated with mining (Figure 28). A wooden frame structure covers the winding engines, both "new" and "old." There was also a fan shaft structure, with a chimney, screens, workshop, office, and several unlabeled structures which may represent colliers houses (Schmitz 1895, Shaler and Woodworth 1899, Roberts 1928, Wadleigh 1934, Eavenson 1942, Ritz 1975). Refer to Table 6 for potential archeological features.

Figure 28

U. S. GEOLOGICAL SURVEY NINETEENTH ANNUAL REPORT PART II PL. XXIV



Plan and section of Raccoon Coal Mine, near Winterpock (Clover Hill) (After Clifford in Shaler and Woodworth 1899).

56. **Rudd Mine** - operated summer and fall seasons in 1920s. This mine was worked by A.A. Rudd for local use. 100 to 200 tons was the average annual production. This mine was probably a shallow pit excavated in outcropping coal (Roberts 1928). This mine site probably would contain little archeological information, as the work done here was on such a minor scale. Refer to Table 6 for potential archeological features.

57. **Rowlett Pits, Appomattox Company Pits** - operated between c1820s-late 1840s. The Rowlett Pits were actually several closely spaced slopes worked for two years, and then abandoned. The Appomattox Company dug exploration pits in 1842, and mined successfully for several years. They may have been coking a quantity of their small coal in large brick ovens. The small coal was too costly to transport and was considered worthless, however, coking it would have turned a profit (Wooldridge 1841, Tuomey 1842, Eavenson 1942, Ritz 1975). Refer to Table 5 for potential archeological features.

** **Dupuy and Powall's Pits** - opened early 1800s and located in the vicinity of Dutoy Creek. One-third interest in these Powhatan county pits was offered for sale on October 6, 1820 by John Jones. The coal obtained from the pits was reported to be of excellent quality, and an output of 105,00 bushels was reported in the Richmond ***Compiler*** (Eavenson 1942). Refer to Table 5 for potential archeological features.

** **Jawbone Shaft** - dates of operation and exact location unknown (Roberts 1928, Wadleigh 1934).

** **Mann Shaft** - dates of operation and exact location unknown (Roberts 1928, Wadleigh 1934).

** **Vaden Shaft** - dates of operation and exact location unknown (Roberts 1928, Wadleigh 1934).

Huguenot Springs/Manakin District

Coal mining in this area had begun as early as 1700, perhaps earlier by Huguenot settlers. The Dover coal pits were still in operation in 1805, when an advertisement in the ***Virginia Argus (July 20, 1805)*** described the "Coal Lands at Dover." Ross and Currie, the leasers, added that they would be willing to "attach to the colliery a small Farm...with useful improvements." On November 1806, the property was leased for seven years at a rental of $666.66 per year and 1 cent per bushel for each bushel raised over 66,666 (Heth Family Papers: Ross and Currie to James Tally, 1806).

In 1814, an interest in the Dover Coal Pits was for sale by Cornelius Buck. The property consisted of a tract of 119.5 acres, and the right to mine coal in an adjacent tract. His advertizement in the ***Richmond Enquirer*** on November 29, 1814 described the pits as being "...in good order for working, having several shafts sunk into large bodies of coal of superior quality, so that they may be worked several years at but little expense".

On December 5, 1815, Thomas Taylor, owner of an undivided third interest in the Dover Coal Pits, offered for sale 90 acres in the ***Richmond Enquirer***. Daniel Triplett's share in the Dover mines was listed for sale. His advertisement in the December 4, 1817 issue of the ***Richmond Enquirer*** said that "existing shafts would yield 3 to 400,000 bushels, and by sinking one more-that from 800,00 to 1,000,000 bushels may be raised."

(*The following individual mines were collectively known as the Dover Mines, or Dover Coal Mines or Pits; see Figures 13 and 14)

** ***Graham's Pits, Anderson and Moody's Pits, Dover Pits** -operated before 1795. On June, 1796, the Duke de la Rochefoucault Liancourt visited one of the earliest mines, known as Grahams' Pit. It was operated by Graham and Havans, and they employed about 500 African-American slaves both at the mine and the farm on which it was located.

In 1837, Edmund Ruffin, editor of the ***Farmer's Register***, visited Graham's Coal Pits. Edward Anderson, one of the mine's owners, accompanied Ruffin in his examination of the mine. Apparently sometime before 1837, Graham, a "rich old Scotchman," had sold the property. Graham was though to have had:

> "...a greater passion for opening new shafts, than resolution and perseverance to exhaust the coal to which each opened. The land is blackened and defaced throughout by the sites of numerous old shafts, and the heap of slate and remains of refuse coal....These shafts (or perpendicular pits, through which the coal is lifted,) were sometimes within fifty or sixty yards of each other...from no one shaft was half the coal raised....It seems indeed, as if he dug shafts merely to ascertain the extent and state of the coal bed, and in many cases partially filled and abandoned them, as soon as the coal was penetrated. ...When the tract was about to be sold, after

> Graham's death, it was supposed that all these abandoned shafts indicated either exhausted workings, or seams of coal not worth working."

Graham apparently utilized slave labor, even to the extent of having a slave oversee and direct his mining operations. He later freed the slave and paid him $200 a year in wages. However, the management of the mining operations left some doubt in potential buyer's minds about the remaining coal in the tract. Therefore the entire 1,00 acre tract was sold for only $13,000.

Ruffin noted that at one of the shafts (360 feet deep) being worked in 1837, a 10 horsepower steam engine hoisted water in two huge buckets. The water ran down the slope in a stream and "with a pretty equal volume after reaching some distance below, is large enough to turn a mill." Two other shafts were also being worked, and the coal hoisted up in corves by a mule-powered windlass.

Once the coal was hoisted to the pit head, it was loaded by hand into coal cars on a railway located between the two working shafts. The coal cars operated by gravity and mules returned the empty cars to the pit heads. This railway extended to the James River and Kanawha Canal, and in 1837 the railway had been pushed across the canal to the James River. The extension allowed for the frequent disruption of the canal navigation by loading coal into river barges.

A.S. Wooldridge published in the 1842 edition of ***American Journal of Science*** one of the best descriptions of various Richmond basin mines. According to this report the Dover pits were owned by Anderson and Moody, and conveyed to the Dover Coal Mining Company. The mines had become abandoned by c1840, due to the failure of the

Dover Coal Mining Company. After this failure, the mines reverted to the land owners.

Stephen Duval had purchased 981 acres known as the Dover Coal Pits in 1843, and petitioned the General Assembly of Virginia on December 18, 1843, to reassess this land in Goochland county. The tract had been assessed at $116,000 when it was being mined; however, Duval felt that since the tract had been abandoned as worthless by the Dover Coal Mining Company, the value should be lessened.

However, not all the mines in the Dover area had ceased operations. In 1845, the Manakin Iron Works were put in operation by Duval, Churchill, and Company. The water from the Dover Pits, located just to the north, propel the company's furnaces. An undated, detailed map of the Manakin Iron Works (Virginia State Historical Society; Figure 14), founded in January of 1845, revealed an industrial complex south of the James River and Kanawha Canal, the company "dwelling houses," and two coal pits north of the canal. This entire complex is located between the Manakin Ferry Road, to the east, and a farm road, to the west.

The industrial complex is listed as containing a Store house, Nail Factory, Rolling Mill, Furnaces, Blacksmith's Shop, Machine Shop, Saw Mill Copper Shop, Coal Yard, and Grist Mill. The company dwelling houses consisted of four structures at the time the map was drawn, with others constructed after. The four structures vary between one and two storys of brick. One dwelling is specifically labeled as being for "boarders."

The two coal pits represented on this map were part of the Dover Coal Mining Company's pits. The southern most one was known as the Canal Pit. A c1860 map illustrates a larger area of the Dover Mines (Figure 13). The coal shafts and pits labeled on this map represent both the eighteenth century mining done by Graham and others, but also the nineteenth century efforts of the Dover Coal Mining Company, and other individuals as well. The unnamed pits along the western ridge are probably the earliest, where outcropping coal could be easily mined in shallow pits and drift mines. The Gate Shaft, Locust Shaft, Bell Shaft, Main Coal Shaft, Canal Shaft, Fire Pit, and River Pit all represent the more intensive mining efforts that took place after Graham. However, he may have begun a number of these shafts (Wooldridge 1841, Eavenson 1942, Virginia State Historical Society Map F232 G7 1860, Virginia State Historical Society Map MSS IT 599692884-2889). Refer to Tables 4, 5, and 6 for potential archeological features.

58. ***Locust Shaft** - operated during early 1800s, unknown closing date. This shaft was less than 150 feet deep. This shaft is listed on an c1860 Map of the Dover Mines (DeBow 1860, Kimball 1866, Russell 1892, Shaler and Woodworth 1899, Jones 1916, Roberts 1928, Treadwell 1928, Eavenson 1942, Routon 1949, Brown 1952, Virginia State Historical Society Map F232 G7 1860). Refer to Table 5 for potential archeological features.

59. ***Gate Shaft** - opened before 1860, unknown closing date. This shaft is listed on an c1860 Map of the Dover Mines (DeBow 1860, Virginia State Historical Society May F232 G7 1860). Refer to Table 6 for potential archeological features.

60. ***Deep Shaft** - opened during early 1800s, unknown closing date. This shaft was

listed on an c1860 Map of the Dover Mines. The shaft was excavated to a depth of 360 feet, with an additional 40 feet dug for a sump (DeBow 1860, Virginia State Historical Society Map F232 G7 1860). Refer to Table 5 for potential archeological features.

61. ***Aspinwall Shaft** - operated between mid-1800s-early 1900s. This shaft was opened by the Dover Coal Mining Company, under Superintendent Gen. Charles P. Stone. Two circular bricklined shafts were sunk approximately 50 feet apart. Each shaft was 10 feet in diameter, and one shaft was 300 feet deep and the other 935 feet deep (Woolfolk 1901, Jones 1916, Roberts 1928, Swartout 1930, Wadleigh 1934, Brown 1937). Refer to Tables 5 and 6 for potential archeological features.

62. ***Storehouse Shaft** - discovered 1701; opened before c1750 and closed after c1860. A 6- by 14 foot shaft was sunk 325 feet to reach coal. The mine was first worked by Anderson and Moody, and later the Dover Coal Mining Company. This may also be known as the "Main Coal Shaft" on an c1860 map of the Dover Mines (Woolfolk 1901, Treadwell 1928, Swartout 1930, Eavenson 1942, Virginia State Historical Society Map F232 G7 1860). Refer to Tables 4, 5, and 6 for potential archeological features.

63. ***Canal Shaft** - opened before early 1800s, unknown closing date. This shaft, 6-by 8-foot, was 275 feet deep with a 500 foot slope at the base. Ventilation was provided by dividing the shaft in half with wooden brattice. The mine was originally owned by the Tredegar Iron Manufacturing Company, probably to supply their own needs, and was

subsequently sold to the Dover Coal Mining Company in the early 1800s (DeBow 1860, Jones 1916, Virginia State Historical Society Map F232 G7 1860, Virginia State Historical Society Map MSS IT 599692884-2889). This site has since been filled in, with damage done to the shaft area itself. A steam engine foundation was visible 25 feet to the northwest of the shaft entrance. Refer to Table 5 for potential archeological features.

64. ***River Pits** - operated between 1700s-c1860. This site was originally worked by Wills, Brown, and Company in the 1700s, and later they were sold and operated by the Dover Coal Mining Company. The coal was mined from slopes extending 396 feet below the James River. A mule-powered windlass attempted to keep the slopes free of water (DeBow 1860, MacFarlane 1875, Rogers 1884b). Refer to Table 4, 5, and 6 for potential archeological features.

65. **Towne Pit, Towne & Powell Pit** - opened early to mid-1800s, unknown closing date. Dr. Towne had this mine sunk on the eastern end of Sabot Island. In 1841, approximately 20 hands were employed, and raised over 100,000 bushels. By 1843, over 30 hands could be employed at the pit. Reportedly, this pit produced only coke which would have been very profitable for the owners (Wooldridge 1841, Jones 1916, Eavenson 1942). Refer to Table 5 for potential archeological features.

66 & 68. **Bladon Pits, Scott Pits, Woodward Pits, Kennen Pits, No. 13 Slope** - opened and closed again during 1880s. The first mine, constructed by Mr. Bladon, was

a slope extending under the James River which was mined for a couple of years. After 1880, O'Neil, Haston, and Gabney Company attempted mining again with a new slope, No.13. They wanted to build a rope conveyor across the James River to the Chesapeake and Ohio Railroad, but finances prohibited both coal production and the conveyor (Rogers 1884b, Woodworth 1901, Jones 1916, Roberts 1928). Refer to Table 6 for potential archeological features.

67. **Norwood Mine** - may have opened as early as 1835; operated between c1878-late 1880s. Coal was mined from a slope 300 feet long (Russell 1892, Shaler and Woodworth 1899, Jones 1916, Roberts 1928, Wilkes 1988). The mine site was reclaimed in 1987.

69. **Powhatan Pits, Finney's Pits** - opened during early 1800s, unknown closing date. This mine site was originally worked by Capt. Finney in the early 1800s. Two shafts provided ventilation and haulage; one shaft was 105 feet deep and the other 180 feet deep. A road connecting the Powhatan Pits to the James River was built in 1831 (***Richmond Enquirer*** Feb.3, 1831, Lyell 1847, Rogers 1884b, Cox and Heinrich 1888, Russell 1892, Shaler and Woodworth 1899, Jones 1916, Roberts 1928, Wadleigh 1934, Eavenson 1942). Refer to Table 5 for potential archeological features.

70. **Chesterfield Coal Company Pits** - opened c1932-c1940s. The Chesterfield Coal Company worked this site. One slope was excavated for 225 feet, and one ton coal cars were hoisted by steam-powered engines. The coal was roughly hand-sorted on the

surface. In 1937, seven men worked, producing 15 tons of coal per day. The company's mining permit expired in 1941 (Richmond Times-Dispatch 1937, Virginia Geological Survey field investigations by R.O Bloomer 1937). Refer to Table 6 for potential archeological features.

71. **Old Dominion Pits** - opened early 1800s and worked sporadically at least until 1885. The Old Dominion Coal Company extracted coal from these pits. One shaft was sunk to a depth of 125 feet (Cox and Heinrich 1888, Russell 1892, Shaler and Woodworth 1899, Jones 1916, Roberts 1928, Wadleigh 1934, Eavenson 1942). Refer to Tables 5 and 6 for potential archeological features.

** **Randolph Shaft** - dates of operation and exact location unknown (Roberts 1928, Wadleigh 1934, Bron 1937).

** **Spencer Pit** - dates of operation and exact location unknown (Roberts 1928).

TABLE 4

Potential Archeological Features at Richmond Coal Mining Sites: 1701-1794

Mining Component	Potential Archeological Features
Mining techniques: a) surface collecting b) shallow bell-pits c) trenches d) shafts	 a) basin-shaped depressions (to various depths) on the ground surface b) circular basin-shaped depressions, usually filled with ground water c) linear U- or V-shaped depressions (to various depths) d) circular basin-shaped depressions, with timber, stone, or brick shoring visible at or near the ground surface; usually filled with water
Equipment: a) ladders b) windlasses c) horse (mule) gins	 a) none b) possible post hole features adjacent to the shaft or pit c) possible post hole features adjacent to the shaft or pit, also circular track depression around gin from extensive erosion during the animal's continual circuits
Buildings: a) quarters for workers, slaves, and overseers	 a) brick or stone chimney footings, sometimes a brick or stone foundation; may see building divisions for two or more families
Transportation: a) intrasite road system b) natural waterways	 a) shallow linear depressions leading from the pits to nearest road or wagon path b) none
Attendent Manufacturing Facilities:	none in this period

TABLE 5

Potential Archeological Features at Richmond Coal Mining Sites: 1794-1850

Mining Component	Potential Archeological Features
Mining techniques: a) surface collecting b) shallow bell-pits c) trenches d) shafts	 a) basin-shaped depressions (to various depths) on the ground surface b) circular basin-shaped depressions, usually filled with ground water c) linear U- or V-shaped depressions (to various depths) d) circular basin-shaped depressions, with timber, stone, or brick shoring visible at or near the ground surface; usually filled with water
Equipment: a) pumping and steam engines b) horse (mule) gins c) tramway coal cars	 a) brick or stone foundations, probably partially or completely dismantled for repeated use elsewhere; if wooden shelter was erected, there may be sill or post hole features surrounding the foundation b) possible post hole features adjacent to the shaft or pit, also circular track depression around gin from extensive erosion during the animal's circuits c) none
Buildings: a) pump or steam engine housing b) miners' housing c) company buildings (non-industrial) d) company buildings (industrial)	 a) foundations of brick or stone, or if wooden structure, sill or post hole features b) brick or stone chimney footings, sometimes brick or stone foundation; may see building divisions for two or more families c) brick or stone foundations of varying sizes located farther from the actual mine site d) brick or stone foundations of varying sizes, or if wooden structure, sill or post hole features; located close to the actual mine site
Transportation: (intrasite) a) private access roads b) tramways	 a) shallow linear depressions that connect with either turnpike, canal, or railroad b) shallow, narrow linear depressions leading from mine to road, canal, turnpike, or railroad for tranportation
Attendent Manufacturing Facilities	a) industrial foundations of brick or stone; domestic complex of similar materials (see Appendix A: Dover Coal Pits/Manakin Iron Works)

TABLE 6

Potential Archeological Features at Richmond Coal Mining Sites: 1850-1939

Mining Component	Potential Archeological Features
Mining techniques: a) surface collecting b) shafts	 a) basin-shaped depressions (to varius depths) on the ground surface b) circular basin-shaped depression, with timber, stone, or brick shoring visible at or near the ground surface; usually filled with water
Equipment: a) pump, steam engines, electric pumps b) diamond drilling c) centrifugal, electric fans d) coking ovens e) hand and machine sorting	 a) brick or stone foundations, probably partially or completely dismantled for repeated use elsewhere; if wooden shelter was erected, there may be sill or post hole features surrounding the foundation b) none c) only discernible as a circular void in standing walls; if ruins are not present then use of this equipment would be unknown d) brick beehive ovens would leave foundation remains, with scorched earth beneath the coking feature e) possible brick or stone foundation for wooden structure over this area, wooden structure may have had no foundation, and therefore only post hole features would be present
Buildings: a) pump, steam engines, electric pump housing b) miners' housing c) company buildings (non-industrial) d) company buildings (industrial)	 a) foundations of brick or stone, or if wooden structure, sill or post hole features b) brick or stone chimney footings and foundations; may see building divisions for two or more families c) brick or stone foundations of varying sizes located farther from the actual mine site d) brick or stone foundations of varying sizes, or if wooden structure, sill or post hole features; located close to the actual mine site
Transportation: (intrasite) a) private access roads b) tramways	 a) shallow linear depression that connect with eith turnpike, canal, or railroad b) shallow linear depression leading from mine to road, canal, turnpike, or railroad for transportation
Attendent Manufacturing Facilities	a) industrial foundations of brick or stone; domestic complex of similar materials (see Appendix A: Dover Coal Pits/Manakin Iron Works)

BIBLIOGRAPHY

Anonymous
1705 "Plain and Friendly Persuasive to the Inhabitants of Virginia and Maryland for Promoting Towns and Cohabitation." Virginia Magazine of History and Biography Vol. 4.

Anonymous
1880-1883 The Virginias. Vol.I-IV.

Anonymous
1883 "The Richmond Virginia, Coalfield." In The Virginias Vol. IV, No.11.

Arkwright Society
1975 Ironworks.

Ashley, W.J.
1903 The Adjustment of Wages: A Study in the Coal and Iron Industries of Great Britain and America.

Ashton, Thomas S. and Joseph Sykes
1967 The Coal Industry of the Eighteenth Century. Augustus M. Kelley, New York.

Baker, Stephen
1978 "Historical Archeology for Colorado and the Victorian Mining Frontier: Review, Discussion, and Suggestions." Southwestern Lore 44.

Benson, John
1980 British Coalminers in the Nineteenth Century: A Social History. Holmes and Meier, New York.

Beastall, T.W.
1975 A North Country Estate: the Lumleys and the Saundersons as Landowners, 1600-1760. Chichester.

Beverly, Robert
1722 The History of Virginia. Reprinted from Second Revised Edition, London. J. W. Randolph, Richmond, 1855.

Bladon, John
n.d. "Report on Coal Lands in Tuckahoe Valley." In Davis and Evans Richmond Coal Basin 1938.

Brock, Robert A. (editor)
1886 "Documents Relating to the Huguenot Emigration to Virginia and to the Settlement at Manakin-Town." Virginia Historical Society's Collections, New Series, V.

1892 "Orderly Book of Maj. William Heth of 3rd Virginia Regiment." Collections of the Virginia Historical Society. Vol.XI.

Brown, C.B
1937 Outline of the geology and mineral resources of Goochland County, Virginia: Virginia Geological Survey Bulletin No.48.

Brown, Forester
1924 "The History of Boring and Sinking." Mining Association of Great Britain Historical Review of Coal Mining.

Bruce, Kathleen
1968 Virginia Iron Manufacturing in the Slave Era. Augustus Kelley, New York.

Butt, John and Ian Donnachie
1979 Industrial Archaeology in the British Isles. Harper and Row, London.

Buttgenbach, F.
1898 Dererste Steinkohlenbergbau in Europa.

Buxton, Neil K.
1978 The Economic Development of the British Coal Industry. B.T. Batsford, London.

Byrd, William
1866 History of the Dividing Line and Other Tracts. Richmond.

Caffyn, Lucy
1983 "Housing in an Industrial Landscape: A Study of Worker's Housing in West Yorkshire." World Archeology. Volume 15 no. 2, p.173-183.

Carr, Christopher
1985 "Philosophical Framework." For Concordance in Archeological Analyses. Westport Publications, Kansas City.

Channing, Edward
1905 History of the United States. New York.

Chesterfield County Petition 1832. Mss in Virginia State Library.

Chisolm, Michael
1970 Rural Settlement and Land Use: An Essay in Location. Aldine Publishers, Chicago.

Church, Roy
1986 The History of British Coal Industry: 1830-1913 Victorian Pre-eminence. Volume III. Clarendon Press, Oxford.

Clifford, William
1888 "Richmond Coal-field, Virginia." Transactions of the Manchester Geological Society. Vol. XIX. England.

Claflin, M.A.
1978 "Our First Railroads." Chesterfield News-Journal May.

Colliery Guardian
1890 Digest of Evidence given before the Royal Commission on Coal Supplies Vol. I-III. Reprinted 1905, London.

Colls, Robert
1977 The Collier's Rant: Song and Culture in the Industrial Village. Croom Helm, London.

Coryell, Martin
1874 "Eastern Virginia Coal Field." AIME Transactions Vol.3.

Costello, Julia and Judith Cunningham
1987 A Cultural Resourse Survey of the Proposed Royal/Mountain King Mine and National Register Evaluations of Historic Properties, Calaveras County, California. Volume II. Archaeological Services, Inc., Stockton, California.

Coxe, Tench
1794 A View of the United States of America. Printed for William Hall and Wrigley Berriman, Philadelphia.

Coxe, E.T., and O.J. Heinrich
1888 Prospectus of the Virginia Tidewater Coal Company and reports on the property. Martin B. Brown, New York.

Cox, T.B.
1907 Chesterfield County, Its History and Present. Williams Printing Co., Richmond.

Craib, John
1978 Death Valley National Monument: Archeological Survey of 187 Mining Claims. Western Archeological Center, National Park Service, Tucson.

Cunningham, William
n.d. Growth of English Industrialism and Commerce in Modern Times. Cambridge.

Dacey, Michael F.
1966 "The Spacing of River Towns." Annals of the Association of American Geographers 63.

Daddow, Samuel H. and Benjamin Bannan
1866 Coal, Iron, and Oil; or the Practical American Miner. Lippincott & Co., Philadelphia.

Davis, Ira F., and L.S. Evans
1938 The Richmond Coal Basin, A Compilation in Three Parts. Ms. on file at the Virginia State Library, Richmond, Virginia.

DeBow, S. Herries
1860 Reports on the Coal Property of Dover Coal and Iron Company. Charles H. Wynne, Richmond.

d'Invilliers, E.V.
1903 Report on properties of the Richmond Coal Mining and Manufacturing Company: consultants report. Virginia Division of Mineral Resources, Economic Geology Section, Coal files.

Dunn, M.
1852 A Treatise on the Winning and Working of Collieries. Newcastle.

Eaton, Clement
1961 The Growth of Southern Civilization, 1790-1860. New York.

Eavenson, Howard N.
1939 Coal Through the Ages. American Institute of Mining and Metallurgical Engineers. Maple Press, New York.

1942 The First Century and a Quarter of the American Coal Industry. Privately published, Pittsburgh.

1942b "Some Side-lights on Early Virginia Coal Mining." The Virginia Magazine of History and Biography. Vol. L, No. 3. July.

Flinn, Michael W.
1984 The History of the British Coal Industry: 1700-1830 The Industrial Revolution. Volume II. Clarendon Press, Oxford, England.

Ford, Paul Leicester (editor)
1892 The Writings of Thomas Jefferson. 10 Volumes. G. P. Putnam's Sons: New York.

Forester, R.A.
1948 The Development of Management in the South Yorkshire Coal Mining Industry, 1770-1835: A Study of Management at the Fitzwilliam and Norfolk Collieries. Masters thesis, Newcastle-upon-Tyne University.

Gallatin, Albert
1808 U.S. Treasury Department, Report of the Secretary of the Treasury on the Subject of Public Roads and Canals; Made in Pursuance of a Resolution of Senate of March 2, 1807. Washington, D.C.

Galloway, Robert L.
1882 A History of Coal Mining in Great Britain. Macmillan and Company, London.

1898 Annals of Coal Mining and the Coal Trade. 2 volumes. London.

Grammer, John
1819 "Account of the Coal Mines in the vicinity of Richmond, Virginia." American Journal of Science and Arts Vol. I.

Griffen, A.R.
1969 "Bell-Pits and Soughs: Some East Midlands Examples." Industrial Archeology. November.

Hair, T. H.
1839 Sketches of the Coal Mines in Northumberland and Durham. London.

Hair, T.H. and M. Ross
1844 A Series of View of the Collieries in the Counties of Northumberland and Durham, with Descriptive Sketches and a Preliminary Essay on Coal and the Coal Trade. London.

Hardesty, Donald
1988 "The Archaeology of Mining and Miners: A View from the Silver State." Special Publication Series, Number 6. The Society for Historical Archaeology.

1986 "Industrial Archaeology on the American Mining Frontier: Suggestions for a Research Agenda." Journal of New World Archaeology Volume VI, Number 4:47-57.

1985 "Evolution on the Industrial Frontier." In Archeology of Frontiers and Boundaries. S. Green and S. Perlman editors. Academic Press, New York.

n.d. Evaluation of Historical Archeological Resources in Bullfrog Claim and Mining Sites: Nye County, Nevada. National Park Service, Death Valley National Monument [1982].

Hardesty, Donald and Eugene Hattori
1982 Archeological Studies in the Cortez Mining District, 1981. Technical Report 8, Bureau of Land Management, Reno.

Hardesty, Donald and Valerie Firby
1980 Managing Archeological Resources on the Comstock. Heritage Conservation and Recreation Service, National Architecture and Engineering Record, Washington, D.C.

Harvey, Katherine
1969 The Best Dressed Miners: Life and Labor in Maryland Coal Region 1835-1910. Cornell University Press, Cornell, New York.

Haynes, William W.
1953 Nationalization in Practice: The British Coal Industry. Riverside Press, Cambridge.

Heinrich, Oswald J.
1873 "The Midlothian Colliery, Virginia." American Institute of Mining, Metallurgical, and Petroleum Engineers Transactions Vol. 1.

1874 "The Diamond Drill for deep boring compared with other systems of boring." American Institute of Mining, Metallurgical, and Petroleum Engineers Transactions Vol. 2.

1875a "What is the best system for working thick coal seams?" American Institute of Mininf, Metallurgical and Petroleum Engineers Transactions Vol. 2.

1875b "Deep borings with the diamond drill." American Institute of Mining, Metallurgical, and Petroleum Engineers Transactions Vol. 3.

1875c "Remarks on trap dike." American Institute of Mining, Metallurgical, and Petroleum Engineers Transactions Vol. 4.

1876 "The Midlothian, Virginia, Colliery in 1876." American Institute of Mining Engineers Transactions Vol. IV, May 1875 to February 1876.

1877 "An Account of an Explosion of Fire-damp at the Midlothian Colliery, Chesterfield County, Virginia." American Institute of Mining Engineers Transactions Vol. V, May 1876 to February 1877.

Henrico County, Virginia, Board of Supervisors
1893 Henrico County, Virginia: A Handbook, embracing an outline of its history, and a description of its resources. Whittet and Shepperson, Richmond.

Hermelin, S.A.
1783 Mines in the United States.

Hernigle, Jacqueline L.
1987 "Coal Mining in the Richmond Basin." In Opperman et al 1987 Phase I Cultural Resources Survey of the Northern Portion of Proposed Route 288. MAAR Associates Report on file at Virginia Historic Resources and Virginia Department of Transportation, Richmond.

1988 "Coal Mining Resources in the Richmond Basin: Site Survey." In Travers et al 1988 Phase II and Supplemental Phase I Cultural Resources Survey Technical Report. MAAR Associates Report on file at Viginia Historic Resources and Virginia Department of Transportation, Richmond.

Howe, Daniel
1976 Victorian America. University of Pennsylvania Press, Philadelphia.

Howe, Henry
1845 Historical Collections of Virginia. W.R. Babcock, Charleston, South Carolina.

Hudson, Kenneth
1976 Industrial Archaeology: A New Introduction. John Baker, London, England.

Humphrey, H.B.
1959 Historical Summary of Coal Mine Explosions in the United States. U.S. Bureau of Mines Information Circular 7900.

Inouye, Kinsouke
1913 Coal Resources of the World. Vol. I.

J., C.
1708 The Complete Collier. London.

Jevons, W.S.
1865 The Coal Question. London.

Jefferson, Thomas
1787 Notes on the State of Virginia. John Stockdale, London.

Jochim, Michael A.
1976 Hunter-gatherer Subsistence and Settlement: A Predictive Model. Academic Pree, New York.

Jones, Hugh
1724 The Present State of Virginia.

Jones, Phillip N.
1969 Colliery Settlement in the South Wales Coalfield 1850 - 1926. University of Hull Publications, England.

Jones, Meriwether
n.d. "Coal Report on the Richmond Coal Basin." In Davis and Evans The Richmond Coal Basin 1938.

Kimball, I.P.
1866 "Report on Richmond coal basin and mines." In Davis, I.F. and L.S. Evans 1938 The Richmond Basin: A Compilation in Three Parts. Ms on file at the Library of Congress and Virginia State Library.

Kohler, Timothy A. and Sandra C. Parker
1986 "Predictive Models for Archeological Resource Location." Advances in Archeological Method and Theory. Edited by Michael B. Schiffer. Academic Press, New York.

Lacoste, Kenneth, Robert Wall, and Robert Sonderman
1984 An Archaeological Study of the Western Maryland Coal Region: The Historic Resources. Maryland Geologic Survey, Division of Archaeology.

Lafferty III, Robert, Carol Spears, Phyllis Morse, and Hope Gillespie
1985 Cultural Resource Survey, Testing and Predictive Model in the Tyronza Phase II Watershed Area, Mississippi and Poinsett Counties, Arkansas. Report submitted by Mid-Continental Research Associates to the Soil Conservation Service.

Lambert, David
1988 The Field Guide to Geology. Facts On File, New York.

Langhorne, William T.
1981 "Mill-Based Settlement Patterns in Schoharie County, New York: A Regional Study." Historical Archeology 10:73-92.

LaPrade, J.E.
1900 "Map of the Midlothian Coal Company land situated in Chesterfield County, Virginia." In Chesterfield County courthouse deed dated October 24, 1944.

Latrobe, Benjamin Henry
1977 The Virginia Journal of Benjamin Henry Latrobe 1795-1798. Vol. I & II. Edited by Edward C. Carter. Yale University Press, New Haven.

Leach, A.H.
1886 "Improvements in Screening Arrangements." Proceedings Manchester Geological Society 1885. London.

Lewis, Kenneth E.
1984 The American Frontier: An Archeological Study of Settlement Patterns and Process. Academic Press, New York.

Lewis, Ronald L.
1979 Coal, Iron and Slaves. Greenwood Press, Westport, Connecticut.

1987 Black Coal Miners in America: Race, Class, and Community Conflict 1790-1980. University Press of Kentucky, Lexington, Kentucky.

Liancourt, Duke de la Rochefoucault
1800 Travels. Vol. 3.

Lipson, E.
1964 The Economic History of England Volumes I & II. Adam and Charles Black, London.

Lloyd, Peter and Peter Dicken
1972 Location in Space: A Theoretical Approach to Economic Geography. Harper and Row, New York.

Lutz, Frank. E.
1954 Chesterfield, An Old Virginia County. William Byrd Press, Inc., Richmond, Virginia.

Lyell, Sir Charles
1847 "On the Structure and Probable Age of the Coalfield of the James River, near Richmond, Virginia." Quarterly Journal of the Geological Society Vol III. London.

1849 A Second Visit to the United States of North America. Harper and Bros., New York.

Manerin, Louis and Clifford Dowdy
1984 The History of Henrico County. University of Virginia Press, Charlottesville.

Martin, Edward A.
1896 The Story of a Piece of Coal. McClure, Phillips, and Co., New York.

Martin, Edward
1835 Gazetteer of Virginia.

May, Col. John
1788 Journeys to the Ohio Country, 1788-1789.

Miller, Donald L. and Richard E. Sharpless
1985 The Kingdom of Coal: Work, Enterprise, and Ethnic Communities in the Mine Fields. University of Pennsylvania Press, Philadelphia.

Morrison, James L. Jr. (editor)
1974 The Memiors of Henry Heth. Greenwood Press, Westport.

Mott, R.A. and G.J. Greenfield
1936 The History of Coke Making and of the Coke Oven Managers Association. Cambridge.

Munn, Robert F.
1977 The Coal Industry in America: A Bibliography and Guide to Studies. West Virginia University Press, Morgantown.

Nef, John U.
1932 The Rise of the British Coal Industry Vol. I. George Rutledge and Sons, London.

Newell, F.H.
1888 Memoranda concerning the old workings of the Richmond Coal Mining and Manufacturing Company: Consultant's Report. Virginia Division of Mineral Resources, Economic Geology Section, Coal files.

O'Dell, Jeffery M.
1976 Inventory of Early Architecture and Historic and Archaeological Sites. Henrico County, Virginia. Ms on file at Virginia Department of Historic Resources, Richmond.

O'Dell, Jeffery M.
1983 Chesterfield County: Early Architecture and Historic Sites. Virginia Historic Landmarks Commission, Richmond.

Opperman, Antony F., Jacqueline L. Hernigle, Steven Alexandrowicz, Deborah Davenport, Lauren Archibald.
1987 Phase I Cultural Resources Survey of the Northern Portion of Proposed Route 288. MAAR Associates. On file at Virginia Historic Resources and Virginia Department of Transportation, Richmond.

Otto, John S.
1984 Cannon's Point Plantation 1794-1860: Living Conditions and Status Patterning in the Old South. Academic Press, Orlando.

Owen, Colin
1984 The Leicestershire and South Derbyshire Coalfield 1200-1900. Mooreland Publishers, Derbyshire.

Parker, Kathleen A. and Jacqueline L. Hernigle
1990 Portici: Portrait of a Middling Plantation in Piedmont Virginia. Occasional Report No.3, National Capital Region, National Park Service, Washington, D.C.

Paul, Rodman
1963 Mining Frontiers of the Far West. Holt and Rinehart, New York.

Paynter, Robert
1982 Models of Spatial Inequality: Settlement Patterns in Historical Archeology. Academic Press, New York.

Plog, Fred
1978 "Cultural Resource Management and the 'New Archeology'." Social Archeology:Beyond Subsistence and Dating. Academic Press, New York.

Plog, Fred and James Hill

1971 "Explaining Variability in the Distribution of Sites." The Distribution of Prehistoric Population Aggregates. George Gumerman, editor. Prescott College Anthropology Report 1, Prescott College Press, Prescott, Arizona.

Pippin, Lonnie and Ronald Reno

1983 Archeology of the Borealis Project Area. Social Science Center Desert Research Institute, Reno.

Potter, Stephen R.

1991 Personal communication. National Park Service, National Capital Region.

Raistrick, Arthur

1972 Industrial Archaeology: An Historical Survey. The Chaucer Press, Great Britain.

Rayner, Dorothy

1981 The Stratigraphy of the British Isles. Cambridge University Press, London.

Roberts, J.K

1928 The Geology of the Virginia Triassic. Virginia Geological Survey Bulletin 29.

Robertson, T. (editor)

1970 A Pitman's Notebook: the Diary of Edward Smith, Houghton Colliery Viewer 1749. Newcastle.

Rogers, W.B.

1884 "The Age of the Coal Rocks in Eastern Virginia". In Reprint of Annual Reports and other papers on the Geology of the Virginias. Appleton and Company, New York.

Ross, Charles and June Ross

1984 Geology of Coal. Hutchinson Ross Publications, Stroudsburg, Pennsylvania.

Routon, Charles R.

1949 A History of the Midlothian Coal Mines. M.A. thesis, University of Richmond, Richmond.

Ruffin, E.
1837 "Notes of a three day excursion into Goochland, Chesterfield, and Powhatan." Farmers Register Vol. 5.

Russell, I.C.
1892 "The Newark System." U.S. Geological Survey Bulletin No.85. Washington.

Schenkman, David E.
1980 Virginia Tokens. Virginia Numismatic Association.

Schmitz, E.J.
1895 "The Structure of the Richmond Coal Basin." American Institute of Mining, Metallurgical and Petroleum Engineers Transactions Vol. 24.

Schoepf, Johann David
1911 Travels in the Confederation, 1783-1784. Translated and edited by Alfred Morrison. W. J. Campbell, Philadelphia.

Shaler, Nathaniel and Jay Woodworth
1899 Geology of the Richmond basin, Virginia. U.S. Geological Survey 19th Annual Report, Part 2.

Sheldon, Marianne
1975 Richmond, Virginia: The Town and Henrico County to 1820. University of Michigan Dissertation, Michigan.

Shelton, Paul H.
1987 "Premier Minetown." Discover Chesterfield Chronical.

Shepherd, Samuel
1792 The Statutes at Large of Virginia from October Session, 1792, to December Session, 1806, inclusive. Being a Continuation of Hening... Three volumes.

Sloane, Howard and Lucilla
1970 A Pictorial History of American Mining. Crown Publications, New York.

Silliman, Benjamin
1839 "Miscellanies." American Journal of Science and Arts Vol XXXVII. October.

Silliman, Benjamin and O.P. Hubbard
1842 "Chemical examination of Bituminous Coal from the pits of Mid-Lothian Coal Mining Company, south side of James River, fourteen miles from Richmond, Virginia, in Chesterfield County." American Journal of Science and Arts Vol XLII April.

Simms, Steven
1980 Archeological Survey in the Bayhorse Mining District, Custer County, Idaho. Reports of Investigation 80-11, Archeology Center, Department of Anthropology, University of Utah.

Singleton, Theresa (editor)
1985 The Archeology of Slavery and Plantation Life. Academic Press, New York.

Spriggs, Matthew (editor)
1977 Archeology and Anthropology: Areas of Mutual Interest. BAR Supplimental Series 19. Oxford.

Steaveson, A.L.
1859 "The Manufacture of Coke in the Newcastle and Durham Districts." Transactions of the North of England Institute of Mining Engineers Vol. VIII.

Steward, Julian
1938 "Basin-Plateau Aboriginal Sociopolitical Groups." Bureau of American Ethnology Bulletin 150. Smithsonian Institution, Washington, D.C.

1955 Theory of Culture Change. University of Illinois Press, Urbana.

Stutzer, Otto
1940 Geology of Coal. Translated by Adolph C. Noe. University of Chicago Press, Chicago.

Swank James M.
1884 The History of the Manufacture of Iron in All Ages. James Swank, Philadelphia.

Swartout, J.B.
1930 The Richmond Coal Basin. Virginia Division of Mineral Resources, Economic Geology Section, Coal files.

Taylor, R.C.
1835 "Memoir of a section passing through the bituminous coalfield near Richmond in Virginia." Geological Society of Pennsylvania Transactions Vol. 1

Teague, George
1980 The Reward Mine and Associated Sites. Western Archeological Center Publications in Anthropology, No. 11, National Park Service, Tucson.

Teague, George and Lynette Shenk
1977 The Harmony Borax Works. Western Archeological Center Publications in Anthropology, No. 6, National Park Service, Tucson.

Thomas, Gabriel
1698 An Account of Penna.

Thwaites, R.G.
n.d. Jesuit Relations and Allied Documents.

Trachtenburg, A.
1982 The Incorporation of America. Hill and Wang, New York.

Traver, Jerome, Robert Hoffman, Jacqueline L. Hernigle, Stephen J. Hinks, Harding Polk II, Esther C. White, Maryanna Ralph, and Martha McCartney.
1988 Phase II and Supplemental Phase I Cultural Resources Survey Technical Report. MAAR Associates Report on file at Viginia Historic Resources and Virginia Department of Transportation, Richmond.

Treadwell, H.A.
1928 Preliminary Report on the Richmond Coal Basin. Virginia Division of Mineral Resources, Economic Geology Section, Coal files.

Trinder, Barrie
1982 The Making of the Industrial Landscape. J.M. Dent and Sons, London.

Trueman, Arthur
1954 The Coalfields of Great Britain. Edward Arnold Ltd., London.

Tuomey, Michael
1842 "Notice on the Appomattox Coal Pits." Farmers Register Vol. 10, No. 9.

United States Census
1880 Mining Directory. Vol 15.

United States Congress 24th, 2nd Session
1837 Memorial of Virginia Coal Mine Proprietors against Proposed Tariff Reduction. House document 93, January 20, 1837.

United States Geological Survey
1883-1885 Mineral Resources.
1891-1893 Mineral Resources.

Volney, C.F.
1803 Tableau du Sol. Paris.

Wadleigh, F.R.
1934" The Story of the Richmond Coalfields of Virginia." In Davis and Evans The Richmond Coalfield: A Compilation in Three Parts. Ms on file at the Library of Congress and the Virginia State Library.

Weaver, Bettie Woodson
1961 "The Mines of Midlothian." Virginia Cavalcade, winter.

1962 "Mines of Midlothian." Virginia Cavalcade 2:40-47.

1969 "Midlothian, Virginia." Antiques Magazine. October pp.588-590.

1987 Personal communication. Resident of Aetna Hill, Midlothian, Virginia.

Wilkes, Gerald P.
1988 Mining History of the Richmond Coalfield of Virginia. Virginia Division of Mineral Resources Publication 85. Department of Mines, Minerals and Energy, Charlottesville, Virginia.

Willey, Gordon
1953 "Prehistoric Settlement Patterns in the Viru Valley, Peru." Bureau of American Ethnology Bulletin 155. Smithsonian Institution, Washington, D.C.

1989 "Settlement Pattern Studies and Evidences for Intensive Agriculture in the Maya Lowlands." Archaeological Thought in America. Edited by C.C. Lamberg-Karlowsky. Cambridge University Press, Cambridge.

Wilson, Martin and Joseph Slay
1981 "Neighborhoods: Tuckahoe West and the Coal Below." Richmond Lifestyle. November.

Wilson, Thomas
1826 The Pitman's Pay.

Woodworth, Jay Backus
1901 "The History and Conditions of Mining in the Richmond Coal Basin, Virginia." American Institute of Mining Engineers Transactions 31:477-484.

Wooldridge, Abraham S.
1841 "Geologic and Statistical notes of the Coal Mines in the Vicinity of Richmond, Virginia." American Journal of Science and Arts Vol XLII October.

Woolfolk, D.W.
1901 Inspection of the Richmond Coalfield, letter to Mr. Williams of Richmond. Virginia Division of Mineral Resources, Economic Geology Section, Coal files.

Wortham, T.M.
1916 The Richmond (Virginia) Coal Basin. Virginia Division of Mineral Resources, Economic Geology Section, Coal files.

Wright, Louis and Marion Tinling
1948 The Secret Diary of William Byrd of Westover, 1709-1712. Richmond.

Young, Otis
1970 Western Mining. University of Oklahoma Press, Norman.

Zipf, G.K.
1949 Human Behaviour and the Principle of Least Effort. Addison-Wesley, Cambridge.

OTHER SOURCES

England

Calendar of Close Rolls 1302-1307. Great Britain.

Report on the Manuscript of the Marquis of Salisbury Vol XIV. Historical Manuscripts Commission, Great Britain.

Landsdowne Manuscript. 65, no. 9. Great Britain.

Watson Journal
1749 North of England Institute of Mining Engineers, Newcastle-upon-Tyne.

Delaval Manuscript. n.d. Northumberland County Records Office, Newcastle-upon-Tyne.

North of England Institute of Mining and Mechanical Engineers Collections Manuscripts. Newcastle-upon-Tyne.

Iron Industry Housing Papers, Nos. 1-8.
n.d University of Wales Institute of Science and Technology, Department of Architecture.

Royal Commission Coal Supplies XVI,QQ.
1903

State of Virginia

Tompkins Family Papers. Mss. at the Virginia Historical Society, Richmond.

Heth Family Papers. Mss. at the University of Virginia, Charlottsville.

Morris Papers 1797-1798. Mss in Louisa and Goochland Counties.

Chesterfield County Deed Book No.9, 1778-1779
Henrico County Will and Deed Book 1744-1748.

Richmond City Petition 1836. John Heth and Alexander DuVal, et al. Mss. at Virginia Historical Society.

Westham Foundry Accounts 1777-1780. Mss. at the Virginia State Library, Richmond.

Virginia Council Journal 1776-1783 Vol. 2. Ms. at the Virginia Historical Society, Richmond.

Newspapers:

Virginia Gazette issues:
June 13, 1766
September 20, 1766
July 5, 1780

Richmond Enquirer issues:
March 23, 1839
January 7, 1840

Richmond Times-Dispatch
July 16, 1937
December 25, 1937
October 26, 1938
April 21, 1939

New York Mercury July 22, 1765

Maryland Journal and Baltimore Daily Advertiser. January 4 and 7, 1796.

VITA

Jacqueline Louise Hernigle

Born in Cooperstown, New York, January 18, 1963. Graduated from Canajoharie Central High School in Canajoharie, New York, June 1981; received a B.A. in Anthropology from Ohio University in 1985. In September 1985, the author entered the College of William and Mary as a graduate student in the Department of Anthropology, with an emphasis on Historical Archeology. The author began work in 1987 as an archeologist for the National Park Service/University of Maryland, College Park, at the Manassas National Battlefield Park, Manassas, Virginia.